Knowledge.

With which is incorporated Hardwicke's Science Gossip, and the Illustrated Scientific News.

A Monthly Record of Science.

Conducted by Wilfred Mark Webb, F.L.S., and E. S. Grew, M.A.

FEBRUARY, 1914.

ARTIFICIALLY INDUCED PEARL-PRODUCTION.

By H. LYSTER JAMESON, M.A., D.Sc., Ph.D.

The studies of the last dozen years or so directed to the elucidation of the mechanism of pearl-production, and of the pathological conditions which induce or favour it, have made it increasingly clear that the production of a pearl is not, as was formerly largely believed, the direct result of the effort of the mollusc to cover over with nacre an irritating foreign body (*e.g.*, a grain of sand or a parasite), but rather of the presence in the subcutaneous tissues of a portion of the shell-secreting epidermis, in the form of a closed sac, which need not necessarily be associated with any foreign body. The factors that determine the presence or otherwise of such an epidermal "island" seem to differ in different species of molluscs, and in the same species in different localities. The case in which the chain of causation is most fully known is that of the pearls formed through the agency of the trematode *Gymnophallus* in the common mussel, *Mytilus edulis*, worked out by the present writer in 1902 (*P.Z.S.*, 1902, Vol. I, pages 140-166), in which case the mollusc normally surrounds the parasite, while still alive, with a closed sac composed of the outer shell-secreting epidermis; and this sac, on the death of the parasite, or on its migration to another part of the host, lays down concentric layers of the shell substance, so forming a pearl. The fact that *Gymnophallus* invariably becomes surrounded by such a sac, after settling down in the mussel, and that other parasites and foreign bodies do not normally share the same fate, pointed to the conclusion that the formation of the pearl-sac, and consequently of the pearl, is due to some peculiar or specific stimulation on the part of the parasite, and not to mere mechanical irritation, such as would arise from the presence of any foreign body. But the nature of this stimulation, whether mechanical (as, *e.g.*, by the parasite habitually carrying in with it a portion of the epidermis) or toxic (*i.e.*, resulting from an abnormal growth of epidermal cells induced by some specific secretion of the parasite and comparable to the production of plant-galls), is a question which still awaits further investigation.

The artificial production of pearly excrescences, or blisters, on the interior of the shell, by introducing between the mantle and the shell beads or metal images, which become coated over with nacre, has long been practised by the Chinese, and has been developed into a flourishing industry by the Japanese, whose "culture pearls," formed over a core of mother-of-pearl, are now familiar objects in cheap European jewellery. The secret process devised by Linnaeus for producing pearls in fresh-water mussels was analogous to these methods, though never commercially developed; and similar enterprises have been attempted in Burma and

elsewhere. All these processes have, however, so far only resulted in the production of pearly excrescences, or blisters, on the shell; and the successes in the production of free pearls in this manner, which have been claimed from time to time, have not been scientifically demonstrated. Recently, in Japan, Mr. Mikimoto is stated to have produced a few small free pearls by artificial means, but the method adopted has not been disclosed, and success on anything like a commercial scale has not been achieved.

The production of free pearls by mechanical treatment—not, of course, on a commercial scale as yet—has, however, recently been successfully accomplished by Dr. F. Alverdes, working under Professor Korscheldt, at Marburg, and is described in a paper in the *Zoologischer Anzeiger* for September 12th of last year.* The method adopted by Dr. Alverdes was the introduction, by injection into the mantle-parenchyma, of fragments of the shell-secreting epidermis. The molluscs upon which he operated were the fresh-water pearl-mussel (*Margaritana margaritifera* L.), which is still fished for pearls in some of the rivers of Scotland and Ireland, the common pond-mussel (*Anodonta*), and the river-mussel (*Unio pictorum* L.).

The method of treatment was as follows. The shell was held open with a wedge, a portion of the mantle-margin was detached from the shell (to which it is normally bound by the reflected margin of the periostracum), and fragments of the outer shell-secreting epidermis of the mantle were scraped off with a knife; in other cases a small disc of tissue, containing both the shell-secreting epidermis and the ciliated lining of the mantle-cavity, was cut out. These fragments of epidermis, with the connective tissue which remained adherent to them, were then injected into the loose connective tissue of the mantle of the mussel.

After treatment the molluscs were returned to their native waters, where they were kept in suitable enclosures. They were killed, and examined at intervals ranging from two days to twenty-seven weeks. The wound caused by the injection was quickly healed by the migration of wandering cells, to form a scar, leaving intact the introduced "island" of epidermis (see Figures 31 to 33), with such connective tissue as happened to have remained attached to it. These "islands" did not, as might have been expected, fuse with and become indistinguishable from the autochthonous tissues, but remained sharply marked off from them throughout, and no actual concrescence between the transplanted and the autochthonous connective tissue seems to have taken place. Dr. Alverdes found that, when the injected epidermis came to lie with the free surfaces of the cells against the autochthonous connective tissue, it died in a short time. If, however, a fragment of epidermis found its way into one of the cavities which occur in the parenchyma it survived, and spread out around the cavity as though endeavouring to cover over the exposed connective-tissue surface with epidermis, in a manner recalling that figured by the present writer in the developing trematode-sac in *Mytilus* (*loc. cit.*, Plate XIV, Figures 2 and 3). Alverdes considers that the process here involved is not due to a multiplication of the epidermal cells by mitosis, but to a flattening out of the cells, mitotic figures first appearing after the cavity is completely lined with epidermis. By the growth of the epidermis around the cavity in the parenchyma a closed pearl-sac is formed; and then the growth therein of a pearl follows naturally from the normal secretion of this epidermis. If the space lined with epidermis is more or less spherical, so is the pearl; if it is irregular, a pearl of irregular shape results.

The growth of the pearl-sac takes place with remarkable rapidity, being completed in from two to fourteen days. This point is of interest as helping to account for the great difficulty that has been experienced by all workers on the subject in searching for the earliest stages of pearl-sac development in nature.

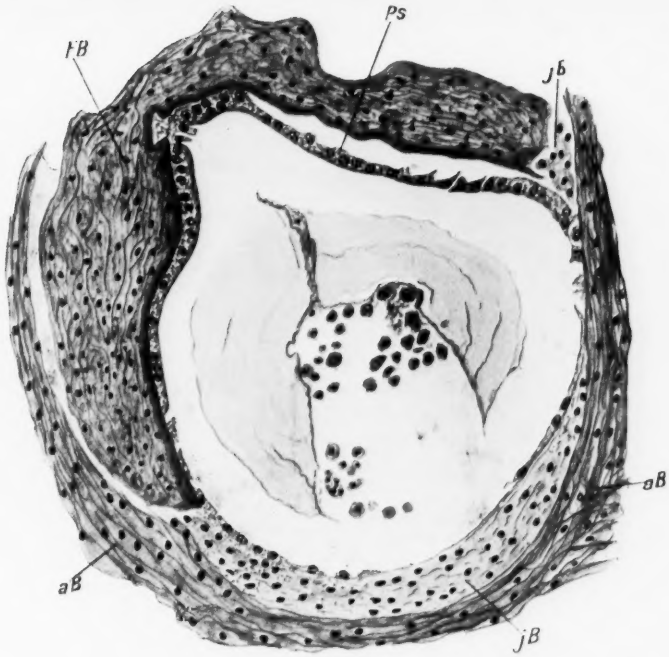
Cysts were also formed by the ciliated epidermis, which lines the mantle-cavity, when successfully injected. It would be interesting to pursue experiments with this tissue, to ascertain whether these ciliated cells would retain their original characters, or whether under any circumstances they are capable of giving rise, either by direct transformation or by cell-division, to shell-secreting epidermis.

The size of the pearls which Dr. Alverdes produced depended, in the first instance, on the sizes of the cavities into which the injected epidermal fragments found their way. They ranged from 30 μ to 1 mm. in diameter. In some cases the secretion of pearly substance in the sac began a few days after the operation; in others it had not started after seven and a half weeks (see Figure 33).

Quite apart from the interest which attaches to so important a step in the direction of the solution of the economic problem of artificial pearl-production, and to the achievement of an end which has long been foreseen by zoölogists, the theoretical value of these experiments is considerable, as adding one more link to the chain of evidence that goes to show that the real determining factors of pearl production are to be sought, not in the efforts of the mollusc to coat over with nacre any intrusive body, but in the presence in the sub-epidermal tissues of an island of epidermal tissue which may have arrived there as a result of purely

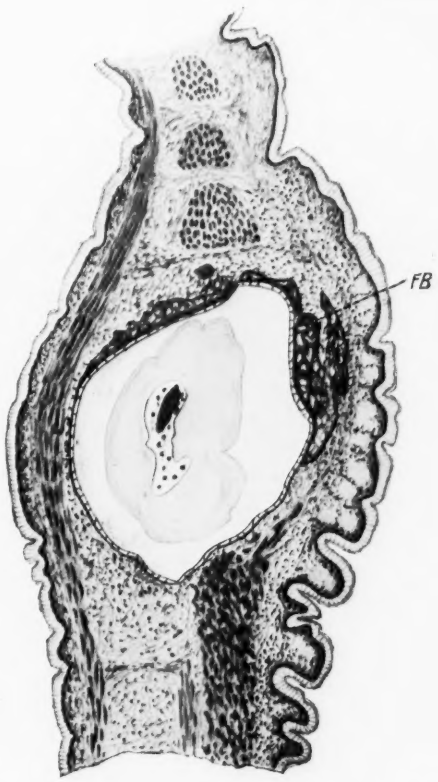
* Versuche über die künstliche Erzeugung von Mantelperlen bei Süsswassermuscheln. *Zool. Anzeiger*, Bd. XLII, Nr. 10, SS. 441-458.

The pearl-sac is not yet completely formed, the epidermal epithelium (Ps) being absent from one side of the cavity (at the bottom of the figure).



Pearly substance, however, is already in process of formation. a B — autochthonous connective tissue; FB — transplanted connective tissue; j B— young transplanted connective tissue. Five days after the operation.

FIGURE 31. Section through an artificially produced pearl-sac in *Anodonta*. × 160.



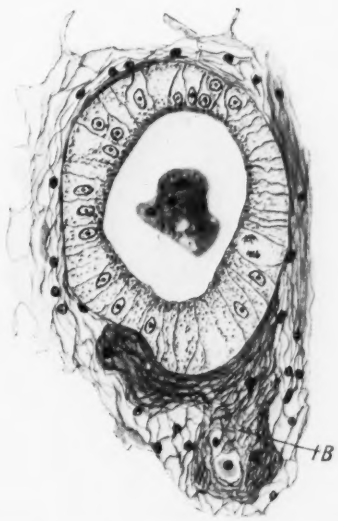


FIGURE 33. Section through an artificially produced pearl-sac in *Unio*, in which a pearl has not yet begun to form. ×300. Remains of dead cells are shown in the centre of the epidermal sac. tB — Transplanted connective tissue. Seven and a half weeks after the operation.

FIGURE 32. Section of an artificially produced pearl (decalcified) about 1 mm. in diameter *in situ* in the mantle of *Margaritana*. ×54. A dark foreign "nucleus" accidentally introduced is seen in the centre of the pearl. FB—Transplanted connective tissues. Twenty-seven weeks after the operation.

From original drawings kindly lent by Dr. F. Alverdes.

XUM

FIGURE 34.

FIGURE 35.

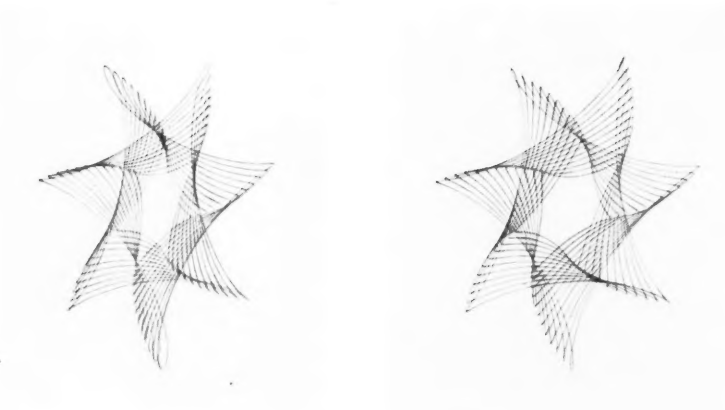


FIGURE 36.

Harmony rendered stereoscopically by applying harmonious oscillatory movement to one of the figures during the simultaneous tracing of the two curves.

Harmony 2 : 5. Counter current,

mechanical processes, as in Dr. Alverdes' experiments, or of the specific action of a particular kind of parasite, as in the case of *Mytilus*, or, as is suggested by Rubbel's recent work on *Margaritana* and allied forms, from some obscure derangement of the normal shell-secreting mechanism. In the pearls produced by Alverdes a "nucleus" was only present when some foreign matter (*e.g.*, quartz grains) was accidentally introduced along with the epidermis, or when cells, derived from the mollusc itself, became isolated in the lumen of the sac, and consequently embedded in the pearl.

Whether Dr. Alverdes' results as they stand are capable of economic application is, as he himself admits, doubtful, owing to the small percentage of pearls of good quality that are likely to be produced; but unquestionably he has brought the solution of the problem of the artificial production of marketable fine pearls by mechanical treatment of the mollusc much nearer than it was before.

A NEW METHOD OF PRODUCING STEREOSCOPIC HARMONOGRAPH CURVES.

By CHARLES E. BENHAM.

A SIMPLE method of producing very perfect stereoscopic effects is applicable, not only to the ordinary Tisley harmonograph, which compounds rectangular movements, but equally to the twin-elliptic pendulum, either Goold's or Benham's miniature form.

The method consists in using two pens on separate levers, working simultaneously, in the manner shown in Figure 37, which illustrates the attachments in the case of Benham's miniature twin-elliptic pendulum. It is obvious that if each pen traces the figure on a fixed card the two tracings will be identical; but if one pen traces on a fixed card and the other on a card mounted on the top of an oscillating pendulum, swinging in one plane only, there will be lateral displacements in the second figure. This lateral displacement may be either discordant with the harmonograph or concordant with one of its movements. If the oscillator is tuned to unison with the main pendulum of the harmonograph the displacement will be equivalent to a uniform slight difference of phase throughout the figure, which is exactly what is required to give a perfect stereoscopic effect, and at the same time the horizontal level of the corresponding parts of the two curves will be preserved, the displacement being only lateral. If the oscillator is discordant a very interesting result is obtained. The amount of stereoscopic relief under these conditions will vary in different parts of the figure with the alternate coincidence and interference of the respective movements of oscillator and harmonograph, the effect in the stereoscope being one of a solid curve thrown into curious undulations which correspond with these alternate coincidences and interferences.

The amplitude of the oscillator's movement must be only small—just sufficient to produce a slight difference in the two figures. Experiment soon reveals the maximum amount of movement admissible. It is important to secure two pens that give an exactly equal line, and to arrange for their starting together. This latter difficulty is easily got over by superposing a loose leaf of paper on the two cards, starting the pair of tracings

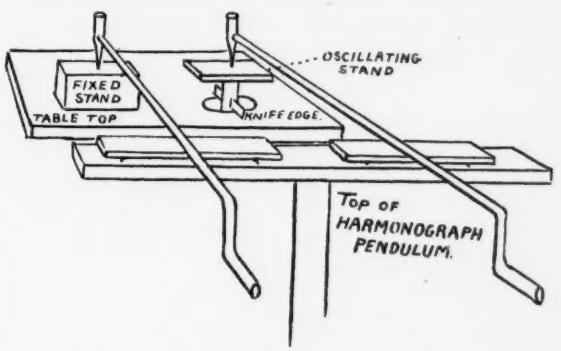


FIGURE 37.

Showing attachments to a Benham's Twin Elliptic Pendulum for stereoscopic curves. The two pens work simultaneously, the one tracing on a card on a fixed stand, the other on a card attached at the same level to the top of a long pendulum oscillating laterally.

on this, and, after the pens have commenced, deftly drawing the loose sheet of paper away in such a direction that both pens commence exactly together on their respective cards.

The pairs may afterwards be mounted, bearing in mind the importance of placing them level with each other and with the displacement lateral.

In Figures 34 to 36 three sets of stereoscopic harmonograph curves are given.

XUM

SOME NOTES ON THE CHEMISTRY OF TOBACCO AND NICOTINE.

By H. STANLEY REDGROVE, B.Sc. (LOND.), F.C.S.

THERE are two chief varieties of the tobacco plant, *Nicotiana tabacum* and *Nicotiana rustica* (see Figures 42 and 44). The flowers of *N. tabacum* are rose-coloured; those of *N. rustica*, which is a smaller plant, are greenish-yellow. The former, the Virginian tobacco, is grown in nearly all temperate and warm countries; the latter is cultivated mainly in the East Indies and Germany. *N. persica*, Persian tobacco (see Figure 43), is now regarded as a variety of *N. tabacum*. The quality of the resulting tobacco varies very greatly, as does also its chemical constitution, according to the climate, soil, method of curing, and so on. The chemical constituents of tobacco are very numerous. Nicotine, combined with malic, citric, and other organic acids, is the chief alkaloidal constituent, but small traces of other alkaloids, namely, nicotinine, nicoteïne, nicotelline, pyrrolidine, and methyl-pyrrolidine, have also been detected. Cellulose and calcium pectate, which serve to give stability to most plant structures, are, of course, to be found in tobacco, as are also albuminoids, resins, chlorophyll, phlobophane, and other complex organic bodies. In addition to calcium, potassium and magnesium also occur, as well as traces of the salts of other metals and ammonium; and in addition to the acids already mentioned, oxalic, acetic, tannic, nitric, silicic, phosphoric, sulphuric, and carbonic are present in the form of various salts. Certain tobaccos also contain a high percentage of saccharine matters, as well as starch.

The results of very complete analyses of a large number of different qualities of tobacco were published in 1887 by Dr. James Bell, Principal of the Laboratory at Somerset House*; and, although the methods of analysis adopted in this undertaking have in certain cases been improved on, the results are still of considerable interest. A few of them are given in Tables 5 and 6. It must be understood, however, as Allen points out in his standard work on chemical analysis, that no chemical analysis can serve as a criterion of the quality of tobacco, since so much depends upon minor differences, such as those of colour, texture, aroma, and so on. For this reason only moisture, ash, and oils are estimated in actual practice, the percentages of these being required for revenue purposes.

Pure nicotine, $C_{10}H_{14}N_2$, is a colourless oil, with a sharp burning taste and a faint ethereal odour. On exposure to air it turns brown and acquires the characteristic odour associated with it in the minds of smokers. It boils at 247° C., and at 15° has a specific gravity of 1·011. It is an optically active body, the naturally occurring variety being laevorotary. Landolt gives $[\alpha]_D^{20}$ as $-161°{\cdot}55$, the more usually accepted value is $-166°{\cdot}39$, whilst F. Ratz† more recently gives $[\alpha]_D^{20} = -169°{\cdot}54$ as the optical activity of a specially purified specimen. Nicotine readily dissolves in water, with which it has been found to form a definite hydrate.‡ It easily passes into vapour in the presence of steam, and this property was mainly made use of in the older methods of estimation.

Nicotine is an excessively violent poison, its action in the pure state being at least as rapid as that of prussic acid. Even in quite small quantities it may produce very unpleasant symptoms, as most smokers are aware from the memory of their first pipe. By continued use, however, the system becomes to some extent protected against the poisonous effects of nicotine; though there can be no question but that the immoderate use of tobacco is highly injurious. On the other hand, the testimony of most moderate smokers is to the effect that such excessively small doses of nicotine as they thereby imbibe are beneficial to the nervous system, and it is a fact beyond dispute that smoking has proved of very great benefit in cases of neurasthenia and insomnia, where other alleged remedies have shown themselves to be useless.

"In order to investigate the effects of pure nicotine Dworzak and Heinrich made auto-experiments, beginning with one milligramme. This small dose produced unpleasant sensations in the mouth and throat, salivation, and a peculiar feeling spreading from the region of the stomach to the fingers and toes. With two milligrammes there were headache, giddiness, numbness, disturbances of vision, torpor, dullness of hearing, and quickened respirations; with three to four

* "The Chemistry of Tobacco" (1887).

† *Monatshefte für Chemie und verwandte Teile anderer Wissenschaften*, Vol. XXVI (1905), page 1241.

‡ C. S. HUDSON: *Zeitschrift für physikalische Chemie, Stöchiometrie und Verwandtschaftslehre*, Vol. XLVII (1904), page 113.

milligrammes in about forty minutes there were a great feeling of faintness, intense depression, weakness, with pallid face and cold extremities, sickness and purging. One experimenter had shivering of the extremities and cramps of the muscles of the back, with difficult breathing. The second suffered from muscular weakness, fainting, fits of shivering, and creeping sensations about the arms. In two or three hours the severer effects passed away, but recovery was not complete for two or three days." *

TABLE 5.

Proximate Analyses of Various Tobaccos dried at 100° C. (Bell.)

Constituents.	Virginia (Ripe).	Turkey.	Havana.	Latakia.	Algerian.	German.	Virginia (Bright).	Kentucky.	China.
Nicotine	3·86	0·90	3·98	1·17	3·13	3·22	2·20	4·59	2·50
Malic Acid	9·06	4·90	12·11	9·07	8·50	12·94	4·17	11·57	7·46
Citric Acid	3·09	1·90	2·05	2·40	3·45	2·89	1·00	3·40	1·58
Oxalic Acid	1·58	1·38	1·53	1·98	1·61	2·51	1·72	2·03	3·91
Acetic Acid	·80	·14	·42	·36	·37	·34	·35	·43	·31
Tannic Acid...	1·34	3·39	1·13	2·33	1·53	·68	6·32	1·48	3·13
Nitric Acid	·43	·05	1·32	·76	·70	·37	·14	1·88	—
Pectic Acid	7·72	9·62	11·36	6·25	10·46	10·23	7·51	8·22	7·48
Cellulose	10·38	9·72	15·76	10·00	12·93	14·48	12·64	12·48	7·98
Starch	—	6·28	—	·69	—	—	1·73	—	1·54
Saccharine Matters...	—	12·07	—	1·46	—	—	14·59	—	12·93
Ammonia	·05	·05	·49	·10	·13	·32	·03	·19	·04
Soluble Extractive Matter rich in Nitrogen	16·24	13·24	7·74	18·97	12·37	8·10	13·47	13·90	14·35
Insoluble Albuminoids	14·29	5·30	9·75	7·25	5·69	6·62	4·68	8·10	4·49
Resins and Chlorophyll	5·21	7·90	5·15	6·62	4·73	2·13	3·41	1·99	6·02
Oils and Fats	1·07	·49	1·03	1·12	3·38	·89	2·27	2·28	·25
Indefinite Insoluble Matter, chiefly Phlobophane	12·93	9·71	8·68	14·94	11·38	12·56	12·41	13·10	12·61
Mineral Matter	11·95	12·96	17·50	14·53	19·64	21·72	11·36	14·36	13·42

TABLE 6.

Analysis of the Ash of Various Tobaccos dried at 100° C. (Bell.)

Constituents.	Virginia (Ripe).	Turkey.	Havana.	Lataka.	Algerian.	German.	Virginia (Bright).	Kentucky.	China.
% of Total Ash on Dry Tobacco (excluding Sand)	14·96	12·92	21·40	18·18	22·17	25·88	12·32	17·98	14·76
Potash ... ... K_2O	34·16	14·51	11·83	19·57	—	—	22·19	16·78	14·44
Potassium Chloride ... KCl	2·53	19·29	12·68	4·06	37·57	24·98	7·01	2·41	3·73
Soda ... ... Na_2O	·86	·54	·81	·55	·41	—	1·46	·06	·41
Sodium Chloride ... ... NaCl	—	—	—	—	1·50	·60	—	—	—
Lime ... ... CaO	18·90	22·54	33·06	34·69	26·38	35·66	21·70	29·51	31·09
Calcium Chloride ... ... $CaCl_2$	—	—	—	—	—	5·89	—	—	—
Alumina ... ... Al_2O_3	·29	·76	·76	·68	·27	·42	·89	·19	·97
Iron, as ... ... Fe_2O_3	·40	·43	·45	·55	·91	·23	2·44	·82	1·10
Magnesia ... ... MgO	6·74	9·21	5·29	5·53	6·55	6·45	12·44	6·78	12·70
Silica ... ... SiO_2	1·55	2·06	1·07	2·03	1·68	·86	·57	4·94	3·38
Phosphoric Anhydride ... P_2O_5	3·23	6·39	4·17	3·62	3·73	2·19	4·72	3·86	5·11
Sulphuric Anhydride ... SO_3	4·32	5·20	4·34	3·67	5·27	3·47	8·29	5·07	4·83
Carbonic Anhydride ... CO_2	27·02	19·07	25·54	25·05	15·73	19·25	18·29	29·58	22·24
Total	100·00	100·00	100·00	100·00	100·00	100·00	100·00	100.00	100.00
% of Sand on Dry Tobacco.	·95	1·80	1·80	·92	·93	·94	1·28	5·26	2·12

* ALEXANDER WYNTER BLYTH, M.R.C.S., F.I.C., F.C.S., and MEREDITH WYNTER BLYTH, B.A., B.Sc., F.I.C., F.C.S.: "Poisons: Their Effects and Detection" (1906), page 281.

XUM

The authors from whom the above account is quoted suggest six milligrammes as probably the fatal dose for an adult not used to tobacco.

There are very few cases on record of poisoning by means of pure nicotine, though one of the few is of historical importance, namely, the murder of M. Fougnies by Count Bocarmé and his wife. This is the first case on record of a pure alkaloid being employed to effect murder. Bocarmé, indeed, had specially taken up the study of chemistry in order to prepare the alkaloid himself. But, as the Blyths remark, "The wickedness and cruelty of the crime were only equalled by the clumsy and unskilful manner of its perpetration." Bocarmé's attempt to destroy all traces of the poison by means of acetic acid was unsuccessful: the famous chemist, Stas, in fact, obtained as much as 0·4 gramme from Fougnies' stomach, showing that the quantity employed must have been excessively great.

Cases of poisoning, both accidental and criminal, by means of tobacco are more numerous, especially the former. Many have occurred through the use of clysters prepared from tobacco, and through external applications of the herb in the form of a poultice, as well as cases in which the poison has been taken through the mouth.

In connection with the physiological action of nicotine, Professor Langley's theory of "receptive substances" must be mentioned. Nicotine is found to produce continued contraction in certain muscles of the bird even after the nerves have been severed. The muscles, however, still respond to direct stimulation, so that, whilst the poison is obviously acting on the muscle and not on the nerves it must be on some constituent of the muscle other than the contractile substance. Analogous phenomena are observed with other chemical reägents, and have led Professor Langley to suggest that in all cell-protoplasm there are present, along with the chief substance concerned with cell-function, receptive substances, which may be acted on by chemical reägents, and can affect the metabolism of the chief substance.

No certain antidote to nicotine poisoning is known, but the above-mentioned muscular contraction is lessened by means of curare, and C. Zalackas* completely counteracted the effect of a fatal dose (twenty-five milligrammes) of nicotine administered to a rabbit by means of two injections of the expressed juice of *Nasturtium officinale*.

The constitution of tobacco smoke has been the subject of some investigation. It consists for the most part of permanent gases, mainly carbon dioxide and carbon monoxide. Hydrogen sulphide, hydrogen cyanide (prussic acid), and ammonia have also been detected. The nicotine is mainly converted into pyridine bases, pyridine (C_5H_5N) predominating in pipe-smoke; collidine ($C_8H_{11}N$) in that of cigars. The latter has a more pronounced physiological action than the former. Part of the nicotine passes into the smoke unchanged.

Various tests have been proposed and employed for the detection of nicotine. Probably the most characteristic is the one due to Schindelmeiser.† One drop of formaldehyde, free from formic acid, is added to the alkaloid suspected to be nicotine, which must be free from resinous matter; then one drop of concentrated nitric acid is added. A deep rose-red colour indicates the presence of nicotine.

Nicotine may also be detected by the aid of the microscope, since certain of its salts crystallise in characteristic forms. This subject has been investigated very fully by Wormley,‡ to whose work I am indebted for Figures 39 to 41 shown herein. In each case the magnification is forty diameters. Figure 39 shows the characteristic form of the double chloride of nicotine and platinum, $C_{10}H_{16}N_2PtCl_6$, produced by the addition of a solution of platinic chloride to a one per cent. solution of nicotine in water in the presence of hydrochloric acid. Mercuric chloride produces, in a one per cent. aqueous solution of nicotine, a copious white precipitate, soon turning yellow and yielding a mass of crystals. These are shown in Figure 40. Most other alkaloids yield precipitates with mercuric chloride, but they remain amorphous, except in the case of strychnine, which, however, produces crystals of quite a different form.

Picric acid in alcoholic solution yields a precipitate, which soon becomes crystalline, with even very dilute aqueous solutions of nicotine. Figure 41 shows that produced in a 0·1 per cent. solution of the alkaloid. The only picrate with which it is likely to be confused is that of sodium.

The estimation of nicotine is of considerable commercial importance, because insectides prepared from tobacco, in which this alkaloid is the essential ingredient, are now in large demand. Considerable attention has been directed to this subject of late years. The older methods of estimation, as already mentioned, made use of the ready volatility of nicotine in steam in order to separate it from the other ingredients of the preparation to be analysed; but steam distillation suffers under the disadvantage that any ammonia present is also carried over. In

* *Comptes rendus hebdomadaires des Séances de l'Académie des Sciences*, Vol. 140 (1905), page 741.

† *Pharmaceut. Zentralhalle*, Vol. XL (1899), page 703. See Allen's "Commercial Organic Analysis," Vol. VI (1912), page 239.

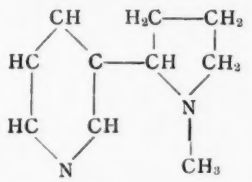
‡ THEODORE G. WORMLEY, M.D., PH.D., LL.D.: "Micro-Chemistry of Poisons, including their Physiological, Pathological, and Legal Relations, etc." (Philadelphia and London, 1885).

Tóth's method* the mixture to be analysed is triturated with caustic soda solution, and plaster of paris is worked in to form a dry mass which will not "bind" when pressed into a lump. This process eliminates any ammonia which may be present. The mass is then extracted by shaking in a stoppered bottle with a mixture of equal volumes of ether and petroleum ether. A known proportion of the fluid is drawn off, diluted with water, and rendered acid by the addition of a known volume of standard acid. The excess of acid is then estimated by trituration with standard alkali, using iodeosin or lacmoid (Kippenberger) as indicator. From the amount of acid used to neutralise the extract the amount of nicotine present may be calculated.

Kissling proceeds in a somewhat similar method to the above; but he extracts with ether alone in a Soxhlet apparatus, evaporates the ether, takes up the residue with dilute caustic soda solution, distils the solution in a current of steam, and triturates the distillate, which contains the whole of the nicotine in a free condition, with standard sulphuric acid. His method has the advantage over that of Tóth that the difficulties of triturating a mixture of water and ether are thereby obviated, and it has been officially adopted.

Degrazia† has devised a polarimetric method of estimating nicotine, whilst Bertrand and Javillier‡ make use of the fact that nicotine may be completely precipitated by means of silicotungstic acid.

Nicotine was discovered by Passelt and Reiman in 1828. In 1891 Blau prepared a compound resembling nicotine, but which was shown not to be chemically identical therewith. The problem of the chemical constitution of nicotine was investigated by this chemist, and more especially by Pinner, who, as the result of a number of experiments, came to the conclusion that nicotine is α–pyridyl–β–tetrahydro–N–methylpyrrol; that is to say, its molecule is represented by the formula:



The accuracy of this formula was conclusively proved by the brilliant research of Amé Pictet and Rotschy,§ who, in 1904, succeeded in preparing nicotine synthetically.

Their method was as follows (see Figure 38): Nicotinic amide (II) was obtained from nicotinic acid (I), and converted by the action of caustic potash and bromine into β–amidopyridine (III). This was combined with mucic acid, and on dry distillation yielded N–β–pyridylpyrrol (IV). Now Pictet had already shown that N–pyrrol derivatives become α–derivatives when heated in a hot tube, thus:

The N–β–pyridylpyrrol was therefore converted into $\alpha\beta$–pyridylpyrrol (V) by this method, and on treatment of the potassium salt with methyl iodide, $\alpha\beta$–pyridyl–N–methylpyrrolemethiodide (VI) was obtained. This body is identical with the methiodide of nicotyrine, which latter compound is produced when nicotine is carefully oxidised. On

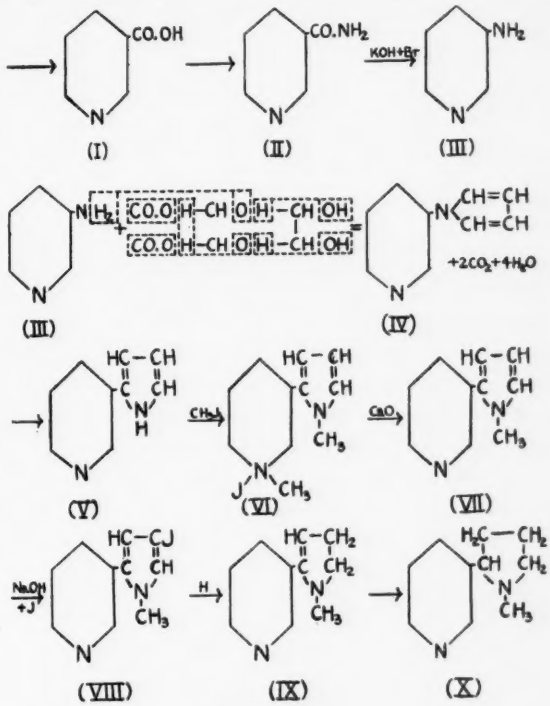


FIGURE 38.

careful distillation with lime the methiodide of nicotyrine yields the parent body, so the next problem was to convert nicotyrine into nicotine. This was effected as follows: The nicotyrine (VII) was treated with caustic soda and iodine, with the production of an iodine substitution product (VIII), which was reduced with zinc and hydrochloric

* *Chemiker-Zeitung*, Vol. XXV (1901), page 610.

† *Fach. Mitt. österr. Tabakregie* (1910), page 87; see *Journal of the Chemical Society*, Vol. C (1911), Part II, page 671.

‡ *Bulletin de la Société Chimique de France*, Series 4, Vol. V (1909), page 241.

§ *Berichte der deutschen Chemischen Gesellschaft*, Year XXXVII, Part II (1904), page 1225. Some of the earlier part of the work was done by Pictet and Crépieux, *loc. cit.*, Year XXVIII, Part II (1895), page 1904.

XUM

acid to dihydronicotyrine (IX). The perbromide was prepared and reduced, yielding α–pyridyl–β–tetrahydro–N–methylpyrrol (X). This body was found to be chemically identical with naturally occurring nicotine. Of course, it was optically inactive, but it was resolved into its optically active isomers by fractional crystallisation of the tartrates. The optical activity of the laevo-nicotine thus obtained was found to be $[\alpha]_D^{20°} = -160{\cdot}93$, thus differing but slightly from that of the natural variety, whilst that of the dextro-nicotine was $[\alpha]_D^{20°} = +163\ 17$. The dextro-variety was found to be less violent in its physiological action than that of the laevo-nicotine; thus, whilst the injection of the laevo-base into a guinea-pig resulted in cramp and violent pains in the extremities, the injection of the dextro-variety appeared to produce no pain. This is seen to be less remarkable than it appears at first sight, when we remember that the bodies of living beings contain very many optically active bodies whose reäctions to optically active isomers may well be expected to be different.

CORRESPONDENCE.

THE LONDON MUSEUM.

To the Editors of "KNOWLEDGE."

SIRS,—May I trespass upon your space to quote a paragraph from a recent London publication?

"It was anticipated that Stafford House, the new home of the London Museum, would be opened this year (1913), but labour and strike troubles have so retarded the work of alteration that the building will not be ready until early in 1914. Mr. Guy Laking, the keeper of the Museum, states that the exhibits will be *very differently arranged* compared with Kensington Palace. *Instead of being classified and set out in sections they will be shown in chronological order.* Thus the visitor on entering the house will first view the pre-historic exhibits, and then pass on to those of successive periods. The Roman boat, which was found near Westminster Bridge a year or two ago, will be in the basement."

From the portion italicised it seems that the keeper of the Museum now admits that the collection at Kensington Palace was not arranged chronologically, which was the contention in my notes sent to you a little time ago. It is pleasing to find that the keeper's own opinion with regard to the arrangement of his collection is now changed, and is more in accord with that of many others, including that of

A PROVINCIAL CURATOR.

A PLANETARY PHENOMENON.

To the Editors of "KNOWLEDGE."

SIRS,—The enclosed extract is taken from Savage Landor's last book (Vol. I), and if you can explain it it will, I think, prove interesting.

"At night, while back in camp, we saw to the W.N.W. quite low on the horizon, a brilliant planet, possibly Venus. The stars and planets appeared always wonderfully bright and extraordinarily large on fine nights. Whether it was an optical illusion or not I do not know, but the phenomenon, which lasted some hours, was seen by all my men, and appeared also when the planet was seen through a powerful hand telescope. It seemed to discharge powerful intermittent flashes, red and greenish, only towards the Earth. Those flashes were similar to, and more luminous than the tail of a small comet, and, of course, much shorter—perhaps four to five times the diameter of the planet in their entire length. Whether this phenomenon was due to an actual astral disturbance, or to light-signalling to the Earth or other planet, it would be difficult—in fact, impossible—to ascertain with the means which I had at my command. Perhaps it was only an optical illusion caused by refraction and deflected rays of vision, owing to the effect upon the atmosphere of the heated rocky mass by our side and under us, such as is the case in effects of mirage. I am not prepared to express an opinion, and only state what my men and I saw, merely suggesting what seem to me the most plausible explanations. At moments the planet seemed perfectly spherical, with a marvellously definite outline, and then the flashes were shot out, especially to the right, as one looked at the planet, and downward slightly at an angle, not quite perpendicularly. That night (May 25th-26th) was cold, min. 58 Fahr., day 85 Fahr."

ERNEST GEORGE ROSE.

BURSLEDON TOWERS,
BURSLEDON, HANTS.

LUMINOUS BIRDS.

To the Editors of "KNOWLEDGE."

SIRS,—I find an article in *The Literary Digest* of October 11th, 1913, entitled "Luminous Birds." The next time that one of these luminous birds is obtained I would suggest that his feathers be soaked in distilled water and a test made for lime. The luminosity is doubtless due to lime which has adhered to the feathers from the droppings which have accumulated in his sleeping quarters. Lime when exposed to sunlight has the property of giving off light in the dark.

M. C. WILKINSON.

P.O. Box 443,
SAN PEDRO, CALIFORNIA, U.S.A.

THE CHEMISTRY OF THE FOREST.

To the Editors of "KNOWLEDGE."

SIRS,—The article by Dr. P. Q. Keegan on "The Chemistry of the Forest" (see volume XXXVI, page 367), is very instructive, but I think his statement is wrong respecting the origin of resin passages in the heartwood of *Pinus*; I think he will find that they form in the autumn growth each year, while the cells are meristematic; and also in the protective tissue. The contents flow through them to any part of the tree and accumulate abundantly where a wound is made. I have never seen active cells in the wood; they are dead when they are ligneous, long before they become heartwood.

The cambium always produces an extra number of cells when a tree has been bruised, exactly where they are most needed; if a branch or trunk is partly broken, the new growth changes its rate of increase because the fracture gives it more freedom in the cortex; the turpentine also flows more easily to the wound.

T. AXON.

LAUREL STREET, STOCKPORT.

THE CHEMISTRY OF THE FOREST.

To the Editors of "KNOWLEDGE."

SIRS,—I am engaged on the study of timber, and I want to find out details of the various secretions contained in each kind of wood; I should, therefore, be very much pleased if I could obtain references to the literature of this subject.

GILBERT R. KEEN.

59, LARKHALL RISE, CLAPHAM, S.W.

XUM

FIGURE 39. $\frac{1}{100}$th of a grain of Nicotine + Platinic Chloride.

FIGURE 40. $\frac{1}{100}$th of a grain of Nicotine + Corrosive Sublimate.

FIGURE 41. $\frac{1}{1000}$th of a grain of Nicotine + Picric Acid.

Figures 39 to 41, ×50 (*after Wormley*).

FIGURE 42. East Indian Tobacco *Nicotiana rustica.*

FIGURE 43. Persian Tobacco *Nicotiana persica.*

FIGURE 44. Virginian Tobacco *Nicotiana tabacum.*

Figures 42 to 44 (*after Heward*).

FIGURE 45. The Bird on the Nest.

FIGURE 48. Nest, Type 3.

FIGURE 46. Nest, Type 1.

FIGURE 49. Nest of Wood Chips and Shells.

FIGURE 47. Nest, Type 2.

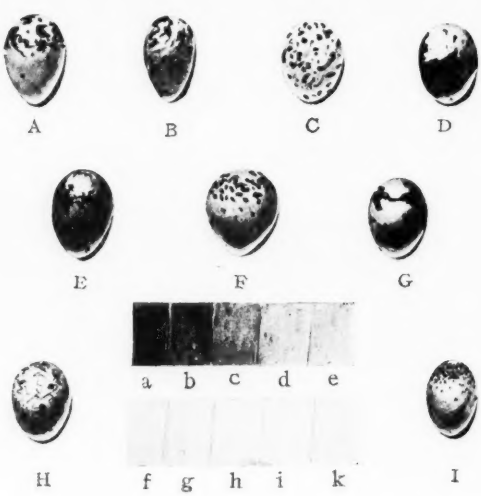


FIGURE 50. Eggs—A–I, types of mottling; a–k, ground colour.

THE COMMON TERN.

SOME OBSERVATIONS ON A TERN COLONY.*

By WILLIAM ROWAN.

THE work of which this is a brief description was carried out, in 1913, on Blakeney Point, Norfolk. The idea was to determine, by means of a census, some of the laws that control the choice of site, nesting materials, and pigmentation of eggs. The work of previous years provided the basis for the methods employed. Many improvements in method suggest themselves, and future work should prove of decided value. This is the first systematic attempt at a census, to our knowledge, and, though we know only too well the many weak points therein, we publish the results as much as a suggestion to ornithologists as for any other reason. The work involved is long and tedious, and results are few.

Blakeney Point is a shingle spit of some eight miles in length. Its extremity projects freely into the sea. On the seaward edge of the terminal mile and a half there is a large open shingle beach; further in are sand dunes, and on the landward side of these are salt marshes and mud flats. At high tide there are nearly two miles of water between these and the mainland.

It was on the seaward side of the dunes on the open shingle that the famous old colony of Terns took up its quarters this year, though there were a score or so of nests on one of the laterals on the lee side of the dunes. It was on the open shingle that the census was taken.

Before describing the results of the census a remark on the movements of a Tern colony may not be out of place. It must not be imagined that because Terns come to the Point year after year therefore they choose the same part of it every time for nesting—far from it. Their choice varies considerably. A few years ago their favourite nesting site was on the lee side of the dunes. Now, however, this part is deserted. Last year the colony was concentrated round those dunes known as the Tern Dunes; this year, however, it has spread right along the beach, and not a nest was found on the dunes proper, while last year a number were located there. Of course, we are only referring to the common Tern now. The erratic nesting habits of the Lesser Tern are well known. This bird, too, was found in considerable numbers.

Two people only were at work, and the month was July, so that we got only the late birds and two hundred and three clutches in all.† Our method of procedure was this. We marked out certain well-defined patches of shingle and together examined these in strips, passing and repassing each other till the ground had been completely covered, when we moved on to another patch.

Four measurements were taken of each egg: long and short circumference, length and breadth. These were taken for biometrical purposes, also the type of mottling and ground colour. Then the egg was numbered with indelible ink, so that it should not be dealt with again. The number in each clutch was then recorded and the type of nest.

In all two hundred and three clutches were found: one hundred and nineteen of one each, sixty-six of two each, eighteen of three each. Of these thirty were abandoned, and the eggs addled and partially buried. Of the clutches containing one egg each we have no proof as to how many consisted of one originally, or in how many cases the one was merely a remnant of a larger clutch.

Three types of nests were taken: (1) No nesting materials and no hole (see Figure 46); (2) no nesting material, but hole scraped (see Figure 47); (3) materials used (see Figure 48). Of these the following number of nests occurred:

Type.	*Number of Nests.*
1	18
2	38
3	120

Of these at least thirty were abandoned.

Of type 3 twenty-four were large, thirty-nine medium, and fifty-seven slight. The majority were made of dried Psamma and similar materials, but four were found in which shells and pebbles had been used, while one contained a large number of crab-legs. In the marshes the drift-line consists of thousands of dead crabs (*Carcinus maenas*), so that the supply was plentiful. One nest was made almost entirely of wood-chips (see Figure 49). Nine nests were found in growing plants of *Arenaria peploides*, and one in living *Triticum*. Some had nests built, others not.

The Common Tern is doubtless a lazy bird, for in the vast majority of cases nests of type 3 were on the drift-line, or some similar situation where material was plentiful. In two years only one nest was found on the drift-line without any material whatever. This was a clutch of three very dark eggs. Nests of a considerable size, far from the drift or other supply of material, were more plentiful, but far from common.

The next thing studied in great detail was the mottling. From the work of previous years a table of types was drawn up (see Figure 50). These were respectively called A—I. It should be pointed out that the size and shape of the eggs on the figure have nothing whatever to do with the mottling, and will be referred to later. Type C was the

* *Blakeney Point Publication*, No. 10.

† The operations of measurement and recording were carried out in conjunction with Miss K. M. Parker, my colleague in the Blakeney Point Field Section for Faunistics.

XUM

commonest, by a long way, with one hundred and five eggs. They come in the following order :

Type.	*Number of Eggs.*
C	105
E	60
B	49
A	27
F	24
H	13
D	8
I	7
G	4

Types with a distinct circle on the round end were A, E, F, and I. They total one hundred and eighteen. This represents nearly thirty-nine per cent. of the total, and the rings are therefore in the minority. One egg was found with the ring halfway down, while two more were found with heavy markings on the pointed end, while the round end was almost free.

Clutches of two eggs each, in which both eggs belonged to the same type of mottling, were in the minority. Out of sixty-six clutches with two eggs each twenty-eight had both eggs belonging to the same type. In the remaining thirty-eight it is remarkable how frequently the types E and C and A and C occur together. The only difference between A and E is that the one has more markings on the lower part of the egg than the other ; and, if they be considered as one type only, the frequency of occurrence is even more marked. In clutches of three the percentage of this combination is even higher. Out of thirteen of these clutches only one had all three eggs belonging to the same type of mottling. In type B (see Figure 50) the twist on the markings should be brought to notice. Where it existed this twist was always in the same direction, downwards from the right to the left. The same thing occurs in the eggs of the Lesser Tern, and is undoubtedly connected with the laying apparatus of the parent bird.

In recording the ground colour a graduated scale was used, *a*–*k*. The eggs were marked according to their shade. On the photograph of the scale (reproduced in Figure 50) the true colour values have unfortunately not come out, and the scale is consequently misleading. On the original the gradation is quite regular.

In clutches of two eggs each the minority had both eggs of the same ground colour. In some cases the difference was enormous. One clutch contained eggs of types *a* and *h* respectively. Others varied to the extent of *c* and *g*, *e* and *i*, *c* and *f*, *b* and *f*. Only a single egg was found to match type *k*.

There were three eggs that could not be accommodated to this scale. One was of a dull slate colour, with mottling also outside the scale. It was with a normal egg. The other two made one clutch. Both were as blue as a thrush's egg. Mottling was also abnormal on both. It is a curious coincidence that both ground colour and mottling should be abnormal on all three eggs.

In clutches of three eggs three clutches had all the eggs of a different ground colour. One clutch had all three eggs alike. Of the other nine, all had two eggs alike ; with two exceptions only, these were lighter than the third.

In length the eggs varied from 3·6 centimetres to 4·7 centimetres ; in breadth, from 2·6 centimetres to 3·7 centimetres. The smallest egg was the same length, but a little broader than a normal egg of the Lesser Tern (see Figure 50). F on the same figure shows the broadest egg found. It was as broad as the above was long, and not much longer than its own breadth.

No direct connection could be found between types of eggs and types of nest. There may be none. But a point suggested by our work is that a bird laying one type of egg may lay another type also, but not *any* type. There may be a law controlling range of variation possible to one bird. It remains to be proved that, where extreme differences were found, these were produced by the same bird. We found that, where a dark and light egg existed together, the lighter was usually the more heavily marked.

The use of material for nesting, alike in quality and quantity, is probably more according to law than is usually believed.

Other laws suggest themselves, but they cannot be proved till more work has been done on these tedious and somewhat novel lines. Many interesting results should be attainable.

LAWES AND GILBERT CENTENARY FUND.

DURING the Christmas holidays the Lawes and Gilbert Centenary Fund Committee ceased work so as not to interfere with the ordinary Christmas appeals : it has now begun work again to collect the last £1,600 needed to complete the scheme.

The object of the Centenary Fund is to build and equip a satisfactory laboratory for the prosecution of researches in agricultural chemistry, a subject largely founded on the experiments of Lawes, who was born just one hundred years ago, and of Gilbert, who was born three years later. Those investigators founded the Rothamsted Experimental Station, the oldest, and for many years the best equipped agricultural experiment station in the world. Rothamsted has maintained its high position in respect of its staff and its field plots, but it has fallen behind in laboratory accommodation, and a serious effort is now being made to remedy this defect. The Committee has ascertained that a satisfactory laboratory can be erected and equipped for £12,000, and it has decided to collect the money, and to put up the laboratory this year in commemoration of the centenary of the birth of the founders. Its efforts have been so far successful that only £1,600 is now required ; and an urgent appeal is addressed to all interested in agricultural science to aid the Committee in closing the list so that the work can be put in hand at an early date. Subscriptions should be sent to the Secretary, Rothamsted Experimental Station, Harpenden, Herts.

XUM

STELLAR SPECTROSCOPY FOR BEGINNERS. IV.

By PROFESSOR A. W. BICKERTON, A.R.S.M.

To understand spectroscopy well, it is necessary to have a slight basic acquaintance with many branches of science. Although good work is often done by persons who have not this basic knowledge, their work is not usually so well correlated as a broader training would have rendered it. Deep specialisation is essential to progress, but its tendency to become detached and vicious has been a striking feature of the immediate past. Nowhere is this tendency more marked than in the learned societies. One rather expected this in the professional societies, but that it should mark the amateur's associations somewhat surprised me three years ago when I landed in England. After a year's effort to effect a change it was seen that a new society was necessary, and the London Astronomical Society was established to correlate facts and found a consistent cosmology. It has already done much basic work in investigating existing theories and in interpreting light curves and spectrograms. A really surprising number of complex spectra are now quite understood.

A magnificently equipped and most favourably situated observatory has recently been opened by one of the members in Hampshire to confirm hypothesis by observations. The unique Hartness Turret Observatory in the United States of America will also be largely devoted to work in conjunction with the London Astronomical Society.

As much of the broadly basic scientific knowledge desirable in the study of spectroscopy is of a simple and interesting character some space will occasionally be devoted to these fundamental preliminaries; and, as graphics are so much more perspicuous than analytics, most of the spectroscopic problems will be treated graphically.

The Order in Complex Spectra.

When one sees the beautiful coloured bands and lines produced by the various elements and their compounds in the spectroscope there appears to be no order at all, and the same is true of spectrograms, except in Secchi's first type of stars. A number of spectrograms of these stars have been already used to illustrate these articles. In these stars the element hydrogen shows a most wonderful order. The general difference between spectrograms—that is, stellar spectra photographs—and the same spectra seen by the eye is that the photograph shows much shorter wave-length than the eye. The order seen in the hydrogen overtones scarcely shows in the visual appearance of their element's spectrum. It is only striking when the rays invisible to the eye are seen in photographs. The longest wave-length of the hydrogen bands seen in most of the spectrograms given in these articles can alone be seen by the eye. In the Sun that line is coincident with the H line of calcium, and so is lost to sight. Although the solar stars do not show this order like Vega and γ Lyrae do, yet in the Worthington spectrogram published in "Knowledge" (Vol. XXXVI, page 445) I am able to trace sixteen of these lines in the transparency which I possess; more than a dozen can be seen in the published enlargement In this unique spectrum the hydrogen overtones are circles, and are thin lines instead of the broad bands of Vega or other similar stars.

In Figure 52 I have taken γ Lyrae and plotted it as a curve, in which one set of ordinates are at an equal distance apart. It can be seen that these lines become more and more equal in length, and never pass the wave-length of 3645·6.

The obvious harmonic character of the hydrogen overtones in these stars, sometimes called Sirian, has supplied the clue by which order has been evolved from the complexity of other elements. In the spectrum of the Sun no order can be casually detected; but when we come to study in detail Worthington's wonderful solar spectrogram we shall easily see order; so also shall we do when we study and disentangle the apparently orderless complexity of the elementary spectra. Later on we shall deal with this order in greater detail.

Detection of Elements.

Amongst so much complexity as we see in solar and stellar spectrograms one might think it would be hopeless for the amateur to try to detect the elements. This, however, is not the case. There are characteristic groups of lines of different tints in many of the elements that are easily recognisable. The double lines of D_1 and D_2 of sodium are markedly characteristic; as is also the single line D_3 of helium when its wave-length or colour is also used. It is seen as a very faint ring at the extreme end of the Worthington spectrum.

The two bands of calcium that mark the end of the visible solar spectrum help to distinguish the hydrogen series, because the longer of the two wave-bands—Calcium H, the one towards the red—is almost exactly coincident with a hydrogen band. In Worthington's spectrum enlargement the two calcium lines show well. The H and K Calcium lines are the two rings in the middle of the enlargement. In Figure 423 in "Knowledge," Volume XXXVI (1913), we have a portion of the solar spectrogram and a series of stars. To the right of

XUM

the solar spectrum are seen the two broad bands of calcium. Bands corresponding with one—the broad bands—run all down the series of star spectra. These are Hydrogen ϵ, wave-length A.U. 3970, and Calcium H, wave-length A.U. 3968, whilst Calcium K, wave-length A.U. 3934, is seen as a thin line gradually showing more intensity as we pass from α Leonis to α Aquila.

Many of the lines of the elements run in doublets and triplets of definite colour, and so help in the identification. Of course, some practical work in spectrum analysis is desirable to aid in the detection of the elements. As a rule, a very slight acquaintance with the recognition of elements is all that is necessary to understand stellar spectra; it is the physical characteristics that are chiefly valuable in stellar spectroscopy. It is on this branch of the subject that the New Astronomy of Impact throws so much light.

Whilst much work relating to the detection of the elements is easy, on the other hand some spectra are exceedingly difficult to determine.

Some lines—as those seen in nebulae and called nebulium, and those seen in the corona and called coronium—have never yet been found on Earth at all. The characteristic line of Helium, D_3, was first seen in the Sun, and was not found on Earth until years afterwards. There is a spectrum called "Swan," due to some compound of carbon that is still under dispute, although Baly unmistakably seems to prove it to be carbonic oxide, and lately Fowler has found evidence of the same kind.

Save these and a few other exceptions, most of the lines of spectra, and even those of spectrograms, are fairly well known.

Variation of Spectra with Source of Heat and as Compounds.

The same elements give different spectra when differently treated. They vary with temperature, with pressure, and with the intensity of electric action used. Compounds give different kinds of spectra from elements, and these compound spectra are of two different classes.

Compounds tend to give banded spectra. The spectra of elements generally consist of lines. Banded spectra have also many other characteristics, and line spectra tend to broaden into bands; all these complexities simplify when correlated. The broadened lines of the elements and the bands of compounds have a totally different character. The bands of compounds finish with a sharp edge quite unlike the broadened lines of hydrogen and other elements that finish with a hazy head. This contrast is referred to in detail further on, illustrated by Figures 53 and 54. When the sharp-edged bands of compounds, and also those of some elements, are examined with wide dispersion the bands are found to be made up of lines, and when these lines are more spread out, with wider dispersion are found to become bands.

The solar spectrum can be spread out into a score of yards, and over a score of thousand lines are mapped in Rowland's wonderful charts.

The Simplicity but Great Number of the Problems of Spectroscopy.

The problems before the student of spectroscopy are somewhat similar to these before the student of the New Astronomy of Impact. Most of the problems in each case are simple; the trouble is there are so many of them. The New Astronomy of Impact introduces some sixscore problems, many of them spectroscopic. The majority of these problems offers practically no difficulty. When workers have mastered the fundamental problems of the new astronomy, and of stellar spectroscopy, it will be found that complex spectrograms can nearly all be read as easily and as unmistakably as a printed book. This is true even of such long series spectrograms, so full of striking detail, as the wonderful Cambridge Spectrograms of Novae Geminorum. But our motto must be "Festina lente." (To hurry is to stumble; we shall get along quickly if we take each part separately and allow of no confusion.) First, then, we will try to understand a little more fully the character of the harmonic order of spectra. Figure 52 shows how the series of bands of γ Lyrae suggests a curve that approaches a vertical tangent. When each of these bands is carefully divided on the position of maximum density, and projected upon a series of horizontal lines drawn at equal distances apart, it produces a curve that tends to a vertical finish, which means that the lines of the spectrum crowd in upon one another. But these short waves are so extremely feeble that the head where these lines coalesce is usually invisible.

Balmer has shown that this can be expressed in a formula. Starting from Hα to Hβ, through γ, δ, ϵ, and so on, the wave-length can be expressed as fractions of the wave-length of the head, 3645 A.U.

That is, $\alpha\frac{9}{5}, \beta\frac{16}{12}, \gamma\frac{25}{21}, \delta\frac{36}{32}$ and so on, up to and past ω; now the top row of figures is $3^2=9$, $4^2=16$, $5^2=25$, and so on; and the lower row is $3^2-4=5$, $4^2-4=12$, $5^2-4=21$, and so on; so, if we put m for numbers in order, from 3 upwards, then the formula is $\frac{m^2}{m^2-4}$, and these have certainly been seen up to 29, and some think even further, in stellar spectrograms. Each line as it approaches the head gets more and more indistinct, and so the head or finish of many lines is, as already stated, almost invisible. This is exactly the reverse of the head of the bands of compounds in which the finishing lines are strong.

The heads of the hydrogen series, and of all similar series in the other elements, are towards the violet end of the spectrum. The clear-edged, definite bands of compounds are sometimes towards the violet and sometimes towards the red. They

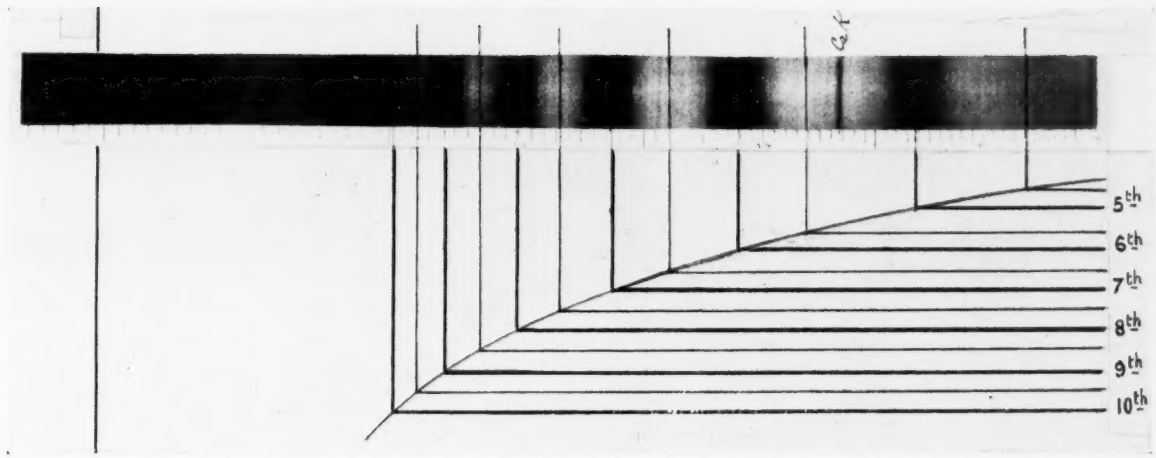


FIGURE 51. Diagram to show the relation of the thin Pickering series of Hydrogen to the ordinary diffused series. Shown on the ordinates by thick and thin lines. Some only of the intermediate wave-lengths are shown and the horizontal distances are taken twice as far apart as in Figure 52 to show the curve more plainly.

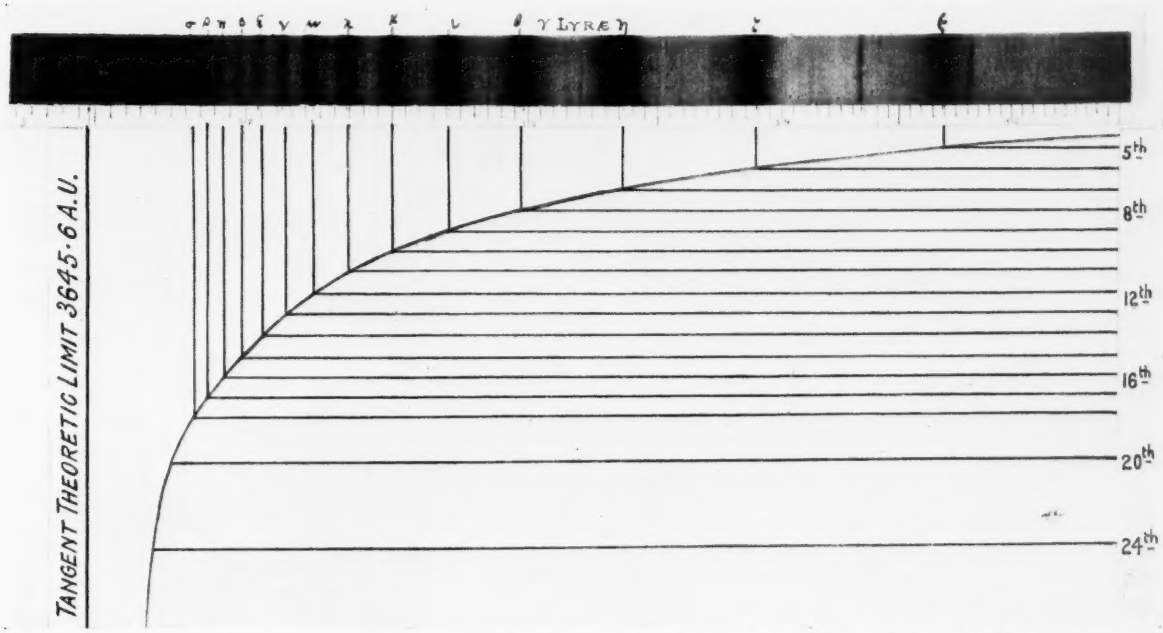
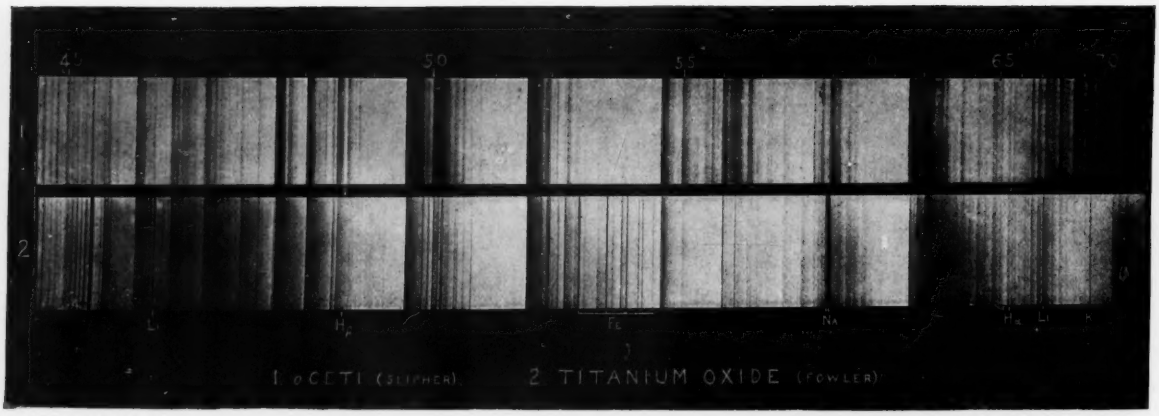
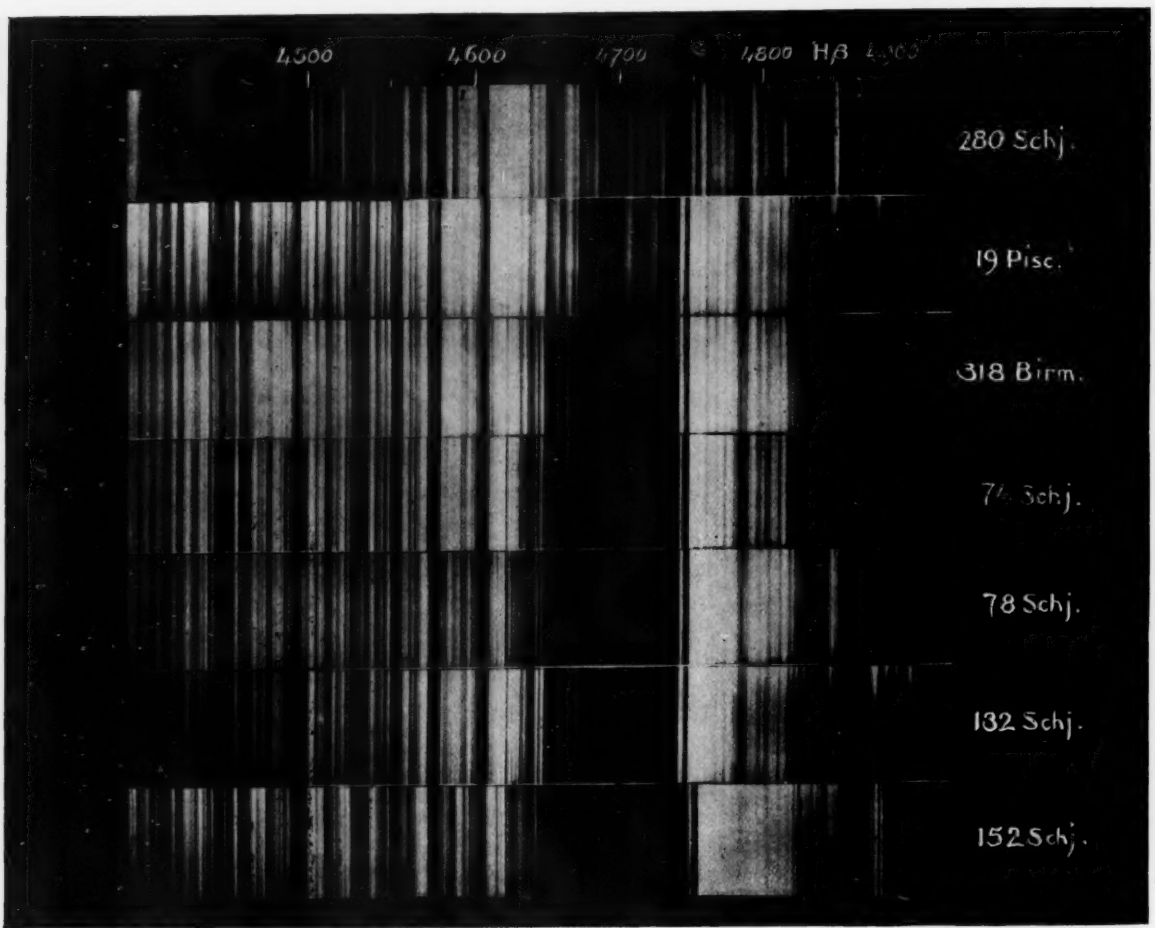


FIGURE 52. Graphic representation of Balmer's Formula, showing up to the 24th line of Hydrogen, diffused series.



From spectrograms by *A. Fowler, South Kensington.*

FIGURE 53. Spectrograms showing the absolute identity of the fluted spectrum of Titanium Oxide and the flutings seen in Mira Ceti. Note that the sharp edge is towards the violet. This is characteristic of third-type stars.



From spectrograms by *G. E. Hale, Mount Wilson Observatory.*

FIGURE 54. Spectrograms showing the sharp edge of the flutings to be towards the red end of the spectrum, as in Carbon compounds, and fourth-type stars.

are towards the red in titanium oxide, in the variable star *o* Ceti (Mira) (see Figure 53) and many other variables, also in third-type stars. In Figure 54 the flutings of fourth-type stars are seen to shade the opposite way, and the same is the case with carbon compounds.

THE PICKERING SERIES OF HYDROGEN LINES.

Pickering, in the star ζ Puppis, found a series of sharp lines intermediate between each of the diffused hydrogen lines; as this relation was very striking he thought they might belong to hydrogen also. It was found, if between 3 and 4 and between 4 and 5 we interposed the fractions 3·5, 4·5, and continued this throughout the series, we had the Pickering series.

If we adopt the graphic method we have used, and put in thin lines for the Pickering series, we shall understand the relation of the two series. We first draw thin horizontal lines midway between the thick horizontal lines, and where these meet our curve draw thin vertical lines; we have then the exact position of the Pickering series (see Figure 51). Laboratory experiments afterwards made on hydrogen succeeded in getting these thin lines from hydrogen.

ORDER IN THE SPECTRA OF OTHER ELEMENTS.

After the order found in hydrogen was discovered, similar-looking, crowding, faint heads were noticed in the spectra of other elements. The alkalies, lithium, sodium, and potassium, were disentangled, and found to consist of three series. Two of these series were like hydrogen, in that these two series of lines were found to have the same head; and also like hydrogen in that one series was sharp and the other diffused. But these were not the most noticeable lines; another series of more emphatic lines had a head of its own further towards the violet: this was called the principal series.

On plotting all these on curves a relation was seen to exist between them. Using the same relation on hydrogen, and looking for the corresponding lines, a number of hitherto unknown stellar lines were found to correspond with these theoretical lines, particularly a bright blue line in a peculiar kind of star, called Wolf-Rayet stars, so called because Wolf and Rayet noticed a spectrum of mixed bright and dark hydrogen lines in certain stars; afterwards Copeland found many more of them. In these stars all these series of hydrogen lines are found: the principal, the diffused, and the sharp. Some of the lines are bright and some are dark.

When we have studied stellar spectroscopy in its relation to the results of "Partial Impact" we shall have many interesting things to say of the remarkable "Wolf-Rayet Stars."

Since finding the principal series of hydrogen lines, some lines in nebulae and in the Sun, formerly of unknown origin, are now known to be from this principal series of hydrogen. This is the remarkable way in which facts, when correlated, and even more so when associated with theories, lead to the discovery of new facts and the correlation of other facts. Yet so have generalisations been neglected that an eminent solar physicist a year or so ago somewhat angrily told me he did not want to have anything to do with theories—he was looking for facts.

HELIUM AND THE COSMIC PIONEER.

But these correlations are only the beginning of this fairy tale of fact. The element Helium was first found in and named after the Sun, and then found in clevite and other minerals, and now found literally everywhere. This element, with its atoms deficient in some of their negative electrons and consequently charged with positive electricity, are the so-called alpha particles that are eternally shooting out of very heavy elements with a velocity sometimes of ten thousands of miles a second. The high velocity of these atoms is the principal origin of the energy of Radium. Helium has a spectrum of extreme complexity.

On looking for heads in order to disentangle its spectrum four were found, two of principal lines and two other heads, each of which had two series, the diffused and sharp, each pair of diffused and sharp having the same finish as is the case in hydrogen and the alkalies. This curious double character suggests to some that it is an element made up of two atoms, although other views are possible. Helium is the lightest of a series of elements of very singular properties. Their names are: Helium, Neon, Argon, Zenon, Cripton. These elements form one of the Mendelief series.

They are all quite neutral, absolute bachelors of the elements. They form no compound at all, and even their molecules are separate atoms. The only uses I have been able to see for them is that perhaps they all help in the building of other atoms, and also aid in the formation of primordial cosmic systems. The origin of these systems I traced out thirty-five years ago, and called "Cosmic Systems of the First Order"; remnants of such a system Kapteyn has now found in the Galaxy. This series of neutral elements that I have named "Cosmic Pioneers" stands between the series of halogens, the most negative of all elements, and the alkalies, the most positive of all elements; so it looks somewhat as though Helium might be made up of a very light positive element and a very light negative element, the pair so very strongly joined by their opposite properties as to be inseparable. The higher atomic weight a negative element of a series has, the stronger it is, and the lighter a positive element of a series is, the weaker it is; so Helium may be built up of a very strong negative, so strongly grasping a positive element that to our power of analysis they are an inseparable pair; but this suggestion seems to leave Helium negative. Anyway, whatever is the structure of the Helium atom, the above is a

XUM

description of the character of the complex lines of its spectrum; in many of the elements the series, instead of being made up of single lines, consists of double lines, as in sodium; of triple, as the alkalies earths. The lighter the atom is in its series the closer are its lines; so that the pairs in the case of potassium are far apart. In sodium a wide slit makes one of the two, and with lithium it is very difficult to separate them.

Advances in the science of spectroscopy are now so rapid, and there is also growing up so much correlation between astronomy and the experimental sciences, that we have reason to hope that many more of the difficulties that still remain will soon be disentangled.

ECONOMICS AT THE BRITISH ASSOCIATION, 1913.

THE address of the sectional president, the Rev. Philip H. Wicksteed, M.A., was entitled "The Scope and Method of Political Economy in the Light of the 'Marginal' Theory of Distribution." The "marginal" theory of distribution rests upon what may be called "the differential theory of exchange." This theory, in Mr. Wicksteed's words, "regards value in exchange as the first derived or 'differential' function of value in use; which is only as much as to say, in ordinary language, that what a man will give for anything sooner than go without it is determined by a comparison of the *difference* which he conceives its possession will make to him compared with the difference that anything he gives for it or could have had instead of it will or would make." This "differential" attitude, Mr. Wicksteed points out, underlies the whole of human conduct, not only that which may be technically termed "economic": we are always considering the differences in the worth or significance of alternatives, and not the absolute worth or significance of things. He maintains that economics has no special laws of its own, but deals rather with special applications of quite general laws concerning human conduct. His address contained, on the basis of the above theory, an interesting criticism of supply and demand curve diagrams, which diagrams he regards as essentially misleading. Mr. Wicksteed asks economists carefully to examine the basis of their theories, to widen and broaden their concepts, that a body of accepted economic doctrine may be established on a scientific basis, and be available for use by social reformers and legislators.

There was some interesting discussion on the subject of canals and waterways in England. Mr. W. M. Acworth, in a paper entitled "A Forward Canal Policy: Its Economic Justification," argued that "the adoption of a forward policy cannot be justified as in the interest of the community at large," on the ground that railways are economically superior to canals as a means of transport. I must confess, however, that I have more sympathy with the progressive policy of Lord Shuttleworth. No doubt railways possess economic advantages over canals, but that is no argument against the improvement of existing canals as auxiliaries to the alternative means of transport. Lord Shuttleworth's paper was entitled "The Improvement and Unification of English Waterways." He advocates: (1) The formation of "a Central Waterway Board to deal with waterways, much as the Road Board deals with roads, without undertaking the business of carrying"; (2) unification; and (3) improvement of one or two of the main routes as a commencement. A similar policy was advocated by Sir John Purser Griffith, M.Inst.C.E., in his paper entitled "Some Reasons why the State should Improve the Canals and Waterways of the United Kingdom." Mr. Frank R. Durham, A.M.Inst.C.E., contributed a paper on "The Waterways of France, Belgium, and Germany."

H. STANLEY REDGROVE, B.Sc. (Lond.), F.C.S.

ELIZABETHAN BOTANY.

THOSE whose acquaintance with botanical literature is limited to the terse but comprehensive descriptions of Bentham and his fellow systematists would receive a rude shock on turning to the writings of the older school of botanists, or pre-botanists, who flourished three hundred years or more ago. The whole subject has changed since those days; the point of view has been profoundly modified. For while the old herbalists had but scant respect for a plant that possessed no healing or remedial virtues, real or fancied, the modern botanist is content to observe points of structure and harmonies of function, and to discover the relation in which the individual plant stands to the totality of living things. "Utility" as the be-all and end-all of research has given place to the observation of fact and the investigation of "law" in this as in other branches of science.

Written chiefly with a view to extolling the medicinal virtues of plants, a strong family likeness runs through all the old herbals, whether the work of the ancient writers Hippocrates, Pliny, and Dioscorides, or of the more recent mediaeval writers. Moreover these old worthies copied shockingly from one another, sometimes with acknowledgment and sometimes without. Pliny is often referred to as the authority for some particular statement, and his views were always treated with the greatest respect by the herbalists of the sixteenth and seventeenth centuries. Unfortunately there is evidence that the acknowledgment in this case does not always spring from a desire to give credit where credit is due. Thus Culpeper, after quoting the classic writer in connection with the name "anemone" (wind-flower), naïvely adds, "Pliny is my author; if it be not so, blame him."

This same Culpeper, who lived long before the days of shorthand and the typewriter, adopted an original, if somewhat drastic, method of curtailing his literary labours. If the plant under review happens to be of wide distribution, and generally plentiful, it is dismissed with a few words drawing attention to its commonness and couched in terms that have a decidedly quaint and piquant ring to twentieth-century ears. For instance, he soon tires of the numerous family of buttercups. Some are described in detail, while for the rest the reader is reminded that "unless you turn your head into a hedge you cannot but see them as you walk"—doubtless an accurate, though scarcely an illuminating statement. In vain do we seek enlightenment from this celebrated herbalist concerning the tansy, which is referred to as "so well known that it needeth no description." The same remark is made in connection with the stinging nettle, together with the pleasant reminder that "they may be found by feeling in the darkest night." On such terms as these authorship must indeed have been a pleasure.

H. JOHN GRAY.

GRAVITATION.

By J. E. CAIRNS, B.Sc.

NEWTON may be called the Father of Physics. His discoveries in mechanics, light, and pure mathematics are the foundations of our modern knowledge on these subjects. He gave us the laws of motion, and we have evolved from them our splendid system of dynamics; he gave us the explanation of the prismatic spectrum in terms of the different refrangibilities of light of different colour, and to-day we have the spectroscope; his theory of fluxions is the basis of our higher mathematics, and were it not for the unfortunate notation he employed, which made us turn to Leibnitz for a better one, the honour of giving mathematics the trend which it still follows would have been his alone. In all the main branches of physics—with the exception of electricity—Newton gave us the start, and we have followed his leading.

Yet the greatest work of his life we have left just as he gave it to us. We know to-day no more about gravitation than the bare law which he expounded: every particle of matter attracts every other with a force directly proportional to the masses involved and inversely proportional to the square of the distance between them. That is all we know about it, and that is as much as Newton himself knew two hundred years ago.

It is remarkable that we should have extended and improved the lesser discoveries so wonderfully while we allowed the greatest achievement of all to lie uncultivated and neglected. It is remarkable and hard to understand; for if from the study of Newton's prism we have learnt the composition of the stars, and have formulated theories of universal inorganic evolution; and if from the extension of his laws of motion we have learnt to discover unseen planets; then from a comparable extension of his noblest work, his law of gravitation, what altogether stupendous results might we not expect. It is strange that men were not spurred on by such a thought. Strange, but a fact!

No theory of gravitation has ever been seriously formulated. We cannot think of Le Sage's theory except as a working hypothesis which does not profess to explain the matter, but only to aid our thinking about it. To conceive of gravitation as the push of multitudinous, ubiquitous particles flying in all directions is not physically justifiable; for then two bodies would tend to approach each other with a force which varied, not as their masses, but as the difference of their surfaces, and not in any wise as the inverse square of the distance between them. We must dismiss this theory, then, as being a very inadequate attempt to explain the phenomenon; and having done so we have no other to fall back upon. It would seem as though physicists were afraid of the subject. Their treatment of it would lead one to think they regarded it with religious awe, as something final, not to be discussed or investigated.

Why, we may well ask, should gravitation have this cestus of unapproachableness placed about it? There is nothing in itself to demarcate it so rigorously from other objects of physical interest. It is a form of energy comparable in its manifestations with magnetism and electricity. These have been studied closely and carefully; that has been left alone. Why, we cannot understand.

Between two bodies of masses M and m at a distance d apart, the force of gravitational attraction varies as $\frac{Mm}{d^2}$; between two electric charges of magnitudes E and e at a distance d apart, the force of electrical attraction varies as $\frac{Ee}{d^2}$; between two magnetic poles of strengths P and p at a distance d apart, the force of magnetic attraction varies as $\frac{Pp}{d^2}$. In these formulae we see the close analogy between gravitational, electrical, and magnetic force: $\frac{Mm}{d^2}$, $\frac{Ee}{d^2}$, $\frac{Pp}{d^2}$. Each force varies directly as one quantity—mass, electric charge, or pole strength—and inversely as the square of another, in every case the distance, thus showing the *radiant* nature of the energy involved. The formulae seem to indicate an analogy between mass, electric charge, and magnetic strength, and in these days when mass is looked upon as a mode of electrical manifestation the analogy may become a pole-star of discovery. It is not unthinkable that gravitation may be the electrical attraction between electrons, as ordinary electrostatic attraction is the attraction between molar masses; that the one may be the attraction of the electricity inside the atom—which *is* the atom—as the other is the attraction of the electricity on the surface of the atom.

We think of electrostatic attraction as being due to strain set up in the dielectric, and we can think of gravitation only in terms of strain in the ether. The cause and the nature of this strain are difficult to comprehend, but considerations of energy may lead us to some first notions.

Since gravitation is a form of energy its production must be due to a transformation of energy in some other form; and the only possible energy which is competent to result in gravitation is the energy of motion of the electron. The cause must lie in matter itself, and must be independent of the nature of matter—solid, liquid, or gaseous. The only entity that we know of as remaining unchanged throughout all material metamorphoses is the electron, and so to the motion of this we must ascribe gravitation. We cannot give this place of dignity to the atom; for we must believe that the motions of atoms are different in compounds from what they are in the elemental state; and hence their gravitational effect would be different, which is not so. Thus we can provisionally trace the cause of gravitation to electronic vibration.

Now light is due to electronic vibration. We might expect, then, that light and gravitation would exhibit some elements in common, and we find they have at least one. They both vary inversely as the square of the distance. This property is the sign-manual of vibrational disturbances, and on it we can justifiably base a belief that gravitation is a phenomenon of ethereal vibrations as much as light is. Thus we are led to the conception that the ether under the influence of gravitation and the dielectric in the neighbourhood of a charged conductor are in a state, not of static strain, but of kinetic vibration.

We cannot see very clearly how these vibrations can produce attraction; but then we are not able to see clearly how attraction can be produced at all, though we know it is produced. So we must not stop for that.

A question that arises is: If gravitation is of the same nature as light, can its waves be reflected and refracted and polarised like light-waves? Possibly they can; but the fact has never been demonstrated. The practical obstacles in the way of such an investigation are enormous and at present insuperable; for the instruments we must use are themselves gravitative, emitting these hypothetical gravitation-waves; and so the issue of any experiment on the properties of the waves would be so confused as to be undecipherable. What could we learn of the laws of optics if our mirrors and our prisms and our screens and the walls and tables of our laboratories were themselves luminous? In order to study light we must be able to produce darkness

XUM

at will, and in order to study gravitation we must be able to secure the absence of it when and where we please. That is at present impossible, but perhaps it will not always be so.

A more fruitful line of thought for the present is, that if gravitation is due to the vibration of electrons its intensity should vary with temperature; that is to say, a body should be heavier when hot than when cold, because of the more energetic vibrations of the electrons. This, it is true, has never been observed to be the case; but we must bear in mind that the absolute value of the gravitative force is very small. We require the pull of a world to make its relative value considerable. Hence any small change which might occur in a piece of matter when heated could not be observed by our instruments. Clerk-Maxwell declared it was possible to detect a difference in weight of one part in five million. If, then, we fail to detect any alteration in the weight of a mass of five poundals (two and a half ounces), we must conclude the change in intensity of the force is less than one millionth of a poundal—an excessively small quantity. Whether the change *should* be observable or not we cannot say, as we know neither the comparative rates of vibration of electrons at different temperatures, nor the relation between intensity of gravitational force and rate of electronic vibration. Such experiments are worth doing again, using larger masses and greater ranges of temperature.

Much may perhaps be learnt by applying such considerations to a charged conductor. Here we have added electrons vibrating on the outside of the conductor, and setting up ethereal disturbances not dissimilar from the gravitative vibrations. It should be a simpler matter to test these for reflection and refraction and other phenomena of vibrational motion, and so obtain a true notion of the nature of dielectric strain. What was learnt in this field might be applicable to the other and more obscure one.

However all this may be, it is clear that the investigation of the nature of gravitation offers no greater theoretical difficulty than that of the nature of electrostatic attraction, and once again its neglect is incomprehensible. The similarity between the modes of action of the two phenomena shows there is an essential similarity between the phenomena themselves. Understanding one we should understand both.

It seems likely, then, that it is the student of electrostatics —a subject somewhat eclipsed nowadays by cathode rays and electrons—who will solve the problem of the balance of the rolling suns and stars and fittingly crown the inheritance which Newton left to us.

OROBANCHES.

By H. STUART THOMPSON, F.L.S.

PERHAPS none of the parasitic Orobanches, or Broom-rapes, are more variable or more locally abundant than the handsome *O. speciosa*. Few are more beautiful and at the same time more damaging to crops, particularly to peas, beans, and vetches, in the South of France, Italy, and Spain. Other species in certain countries do great damage also to crops of clover, lucerne, tobacco, hemp, and so on.

Broom-rapes are so well known in England that it is hardly necessary to state that they are fleshy, leafless plants, deprived of chlorophyll, or green colouring matter, and often of a brownish colour, which live on the roots of a great variety of flowering plants, but especially upon many kinds of Leguminosae. The word "Orobanche" is derived from the Greek *βροβος*, vetch, and *αγχω*, to strangle. There is an illustrated monograph of the genus in German by Beck. The family to which they belong (Orobanchaceae) comprises the Tooth-wort, which grows on the roots of Hazel, and the curious purple-flowered *Lathraea clandestina*, which attacks the roots of Poplar and other trees in the west of France, Spain, and Italy. (It can be seen growing at the foot of a tree in the famous York nurseries of Messrs. Jas. Backhouse & Son.) A closely allied family is Scrophulariaceae, to which various semi-parasitic plants belong, such as *Euphrasia* (Eyebright), *Melampyrum* (Cow-wheat), and *Rhinanthus* (Yellow-rattle).

In Britain there are about ten species of Orobanche, but in France we find three times as many, and at least one hundred are known all together. They chiefly inhabit Southern Europe and Western Asia. *O. speciosa* in its distribution is fairly typical of the genus, for it occurs in Provence, Languedoc, Corsica, and a great part of the Mediterranean region.

In the neighbourhood of Carqueiranne, in the Var, France, in May, *O. speciosa* is often seen in enormous quantities in fields of peas, and also among beans and vetches. Very little appears to be done to rid the district of the pest. The flowering spikes should be cut off before they seed, for the seeds are extremely numerous, and they are known to retain their power of germination for several years in the soil. The spikes are from one to two and a half feet high and very handsome. The stout glandular stem is reddish-brown, yellowish or purple according to the colour of the flowers, which are usually white, more or less streaked with violet. Not infrequently, however, they are purple-brown, or sometimes a pale yellow. The stigmas are usually a reddish-violet, but in yellow and sometimes in white specimens they are orange. The corolla is straighter than in most species, and the large lobes are beautifully crenate, the broad lowest one especially. The hairy sepals are deeply bifid, and about as long as the corolla-tube; while the narrow subulate bracts are longer. After being kept in water a week the blossoms appear to become strangely clammy to the touch, and the water is rendered very foul in a few days.

In the department of the Var, where a score of species of Orobanche and eight kinds of Phelipaea occur, *O. speciosa* even attacks Geraniums and Pelargoniums. On Mont Coudon, a limestone mass near Toulon, *O. minor*, a common British species, has been seen by my friend Monsieur Emile Jahandiez on Evergreen Oak. Few varieties attack trees except *O. laurina* in Italy, and near Pisa *O. Yuccae* can be seen on the Mexican *Yucca aloefolia*.

Certain kinds of Orobanche and Phelipaea, a very closely allied genus, produce subterranean cleistogamous flowers, whose seeds ripen and germinate at a depth of a foot or more. One of these is *Phelipaea lutea* of North Africa, employed in Egypt for colouring textile fabric made of the plant called *Hypaene thebaica*.

It does not seem to be known whether certain kinds of Broom-rape are annual or perennial, nor how long the seeds of many take to germinate; but in 1854 A. Passy sowed seeds of *O. Hederae*, which is occasionally found on ivy in England, which took four years to germinate.

In a field of Narcissus near Carqueiranne, with a few Poppies near, I found an Orobanche which I have been unable to determine, and whether any species is known to be parasitic upon Narcissus I am unaware. The plants were two feet high, the stems very thick and red, and the flowers small, erect, and red.

THE FACE OF THE SKY FOR MARCH.

By A. C. D. CROMMELIN, B.A., D.Sc., F.R.A.S.

TABLE 7.

Date.	Sun. R.A.	Sun. Dec.	Moon. R.A.	Moon. Dec.	Mercury. R.A.	Mercury. Dec.	Venus. R.A.	Venus. Dec.	Mars. R.A.	Mars. Dec.	Jupiter. R.A.	Jupiter. Dec.	Saturn. R.A.	Saturn. Dec.	Neptune. R.A.	Neptune. Dec.
Greenwich Noon.	h. m.	°	h. m.	°	h. m.	°	h. m.	°	h. m	°	h. m.	°	h. m.	°	h. m.	°
Mar. 4	22 57·6	S. 6·7	4 7·9	N. 26·3	23 32·8	N. 0·8	23 18·6	S. 6·0	6 34·9	N. 26·3	20 48·7	S. 18·3	4 41·2	N. 20·8	7 50·5	N. 20·6
,, 9	23 16·2	4·7	8 57·9	N. 20·3	23 18·8	S. 0·5	23 41·5	3·5	6 40·0	26·1	20 53·1	18·0	4 42·0	20·8	7 50·2	20·6
,, 14	23 34·6	2·8	13 30·7	S. 13·2	23 2·1	2·9	0 4·3	S. 1·0	6 45·9	25·9	20 57·3	17·7	4 43·1	20·9	7 49·9	20·6
,, 19	23 52·8	S. 0·8	18 28·9	S. 28·2	22 50·9	5·2	0 27·0	N. 1·6	6 52·5	25·7	21 1·4	17·5	4 44·4	20·9	7 49·7	20·6
,, 24	0 11·0	N. 1·2	22 41·4	S. 8·9	22 48·9	6·8	0 49·7	4·1	6 59·9	25·4	21 5·3	17·2	4 45·8	21·0	7 49·5	20·6
,, 29	0 29·2	N. 3·2	2 15·6	N. 18·0	22 55·5	S. 7·3	1 12·5	N. 6·6	7 7·8	N. 25·1	21 9·1	16·9	4 47·4	N. 21·1	7 49·3	N. 20·6

TABLE 8.

Date.	Sun. P	Sun. B	Sun. L	Moon. P	Mars. P	Mars. B	Mars. L	Mars. T	Jupiter. P	Jupiter. B	Jupiter. L_1	Jupiter. L_2	Jupiter. T_1	Jupiter. T_2
Greenwich Noon.	°	°	°	°	°	°	°	h. m.	°	°	°	°	h. m.	h. m.
Mar. 4	−22·3	−7·2	132·2	−10·5	−21·4	+2·5	345·6	0 59 *e*	−17·4	−0·5	257·5	26·9	2 48 *e*	9 11 *e*
,, 9	23·4	7·2	66·3	+14·9	20·8	3·1	299·0	4 11 *e*	17·8	0·5	326·1	57·4	3 5 *m*	0 29 *m*
,, 14	24·4	7·2	0·4	+20·4	20·0	3·8	252·2	7 23 *e*	18·1	0·4	34·9	88·0	8 53 *e*	7 30 *e*
,, 19	25·1	7·0	294·5	− 2·3	19·2	4·5	205·2	10 36 *e*	18·4	0·4	103·6	118·6	9 10 *m*	8 43 *m*
,, 24	25·7	6·9	228·6	−20·5	18·3	5·3	158·1	1 11 *m*	18·7	0·3	172·4	149·2	5 7 *e*	5 48 *e*
,, 29	−26·1	−6·6	162·7	−18·4	−17·3	+6·1	110·8	4 25 *m*	−19·0	−0·3	241·3	180·0	3 14 *e*	4 57 *e*

P is the position angle of the North end of the body's axis measured eastward from the North Point of the disc. B, L are the helio-(planeto-)graphical latitude and longitude of the centre of the disc. In the case of Mars, T is the time of passage of Fastigium Aryn across the centre of the disc. In the case of Jupiter, System I refers to the rapidly rotating equatorial zone, System II. to the temperate zones, which rotate more slowly. To find intermediate passages of the zero meridian of either system across the centre of the disc, apply to T_1, T_2 multiples of $9^h\ 50^m{\cdot}6$, $9^h\ 55^m{\cdot}8$ respectively.

The letters *m*, *e*, stand for morning, evening. The day is taken as beginning at midnight.

THE SUN continues its Northward March at its maximum speed. Its semi-diameter diminishes from 16′ 10″ to 16′ 2″. Sunrise changes from $6^h\ 50^m$ to $5^h\ 42^m$; sunset from $5^h\ 35^m$ to $6^h\ 28^m$. The Sun crosses the Equator March 21st $11^h m$, when spring commences.

MERCURY is an evening star till the 9th, then a morning star. Semi-diameter 5″. Illumination diminishes from $\frac{1}{8}$ to zero, then increases to $\frac{1}{8}$. It is $6\frac{1}{2}°$ N. of Venus on 6th.

VENUS is an evening star, but still too near the Sun for convenient observation. Disc practically full. Semi-diameter 5″. Superior conjunction was on February 11th.

THE MOON.—First Quarter $5^d\ 5^h\ 3^m\ m$; Full $12^d\ 4^h\ 18^m\ m$. Last Quarter $18^d\ 7^h\ 39^m\ e$. New $26^d\ 6^h\ 9^m\ e$. Perigee $12^d\ 10^h\ e$. Apogee $27^d\ 4^h\ e$, semi-diameter 16′ 43″, 14′ 43″ respectively. Maximum Librations, 5^d 7° S, 6^d 8° E, 17^d 7° N, 19^d 7° W, Apr. 1^d 7° S. The letters indicate the region of the Moon' slimb brought into view by libration. E. W. are with reference to our sky, not as they would appear to an observer on the Moon. (See Table 10.)

MARS is slowly advancing. It is about 8° West of Pollux at the end of the month. It will be seen that both hemispheres of Mars are observable, but the Northern one is best placed. The semi-diameter during March diminishes from 5″ to 4″. The unilluminated lune is on the East: its width increases from $\frac{4}{10}$″ to $\frac{8}{10}$″.

JUPITER is still badly placed, having been in conjunction with the Sun on January 20th. It is a morning star. Polar semi-diameter, $15\frac{1}{2}$″.

Configuration of satellites at $5^h\ 30^m m$ for an inverting telescope.

TABLE 9.

Day.	West.		East.		Day.	West.		East.	
Mar. 1	43	○	21		Mar. 17	432	○	1	
,, 2	431	○	2		,, 18	42	○		31●
,, 3	432	⊙			,, 19	41	○	23	
,, 4	42	○	$\frac{3}{1}$		,, 20	4	○	123	
,, 5	1	○	23	4●	,, 21	421	○	3	
,, 6		○	2143		,, 22	234	○	1	
,, 7	21	○	34		,, 23	31	○	24	
,, 8	3	○	14	2●	,, 24	3	⊙	14	
,, 9	31	○	24		,, 25	231	○	4	
,, 10	32	○	14		,, 26		⊙	234	
,, 11	2	○	14	3●	,, 27		○	1234	
,, 12	1	○	234		,, 28	21	○	34	
,, 13		○	1243		,, 29	2	⊙	14	
,, 14	214	○	3		,, 30	31	○	42	
,, 15	43	○	1	2●	,, 31	34	○	21	
,, 16	431	○	2						

The following satellite phenomena are visible at Greenwich, all in the morning hours, $3^d\ 5^h\ 53^m\ 15^s$ I. Tr. E.; $10^d\ 5^h\ 36^m\ 44^s$ I. Tr. I.; $15^d\ 5^h\ 25^m\ 45^s$ II. Ec. D.; $18^d\ 5^h\ 21^m\ 18^s$ III. Ec. D.; $24^d\ 5^h\ 7^m\ 29^s$ II. Sh. E.; $25^d\ 5^h\ 44^m\ 25^s$ I. Ec. D.; $26^d\ 5^h\ 21^m\ 5^s$ I. Sh. E.; $31^d\ 4^h\ 50^m\ 22^s$ II. Sh. I. Attention may be called to the fact that Professor R. A. Sampson's new tables of

Jupiter's satellites are used for the first time in the Nautical Almanac; we may expect a considerable increase of accuracy in the predictions.

The eclipses will take place to the left of the disc in an inverting telescope, taking the direction of the belts as horizontal. Satellites 1, 2, and 4 will all be close together on the morning of the 13th.

$1^d\ 2^h{\cdot}1m$, $9^d\ 7^h{\cdot}2m$, $17^d\ 0^h{\cdot}3e$, $25^d\ 5^h{\cdot}5e$; Rhea (every second given), $6^d\ 8^h{\cdot}6m$, $15^d\ 9^h{\cdot}6m$, $24^d\ 10^h{\cdot}7m$. For Titan and Iapetus E.W. mean East and West Elongations; I. Inferior (North) Conjunctions, S. Superior (South) ones. Titan, $1^d\ 9^h{\cdot}9e$ S., $6^d\ 0^h{\cdot}6m$ E., $10^d\ 0^h{\cdot}6m$ I., $13^d\ 9^h{\cdot}7e$ W., $17^d\ 9^h{\cdot}6e$ S., $22^d\ 0^h{\cdot}6m$ E., $26^d\ 0^h{\cdot}4m$ I., $29^d\ 9^h{\cdot}3e$ W; Iapetus, $6^d\ 5^h{\cdot}0m$ E., $27^d\ 1^h{\cdot}2m$ I.

TABLE 10. Occultations of stars by the Moon visible at Greenwich.

Date.	Star's Name.	Magnitude.	Disappearance.		Reappearance.	
			Mean Time.	Angle from N. to E.	Time.	Angle from N. to E.
1914.			h. m.		h. m.	
Mar. 2 ...	μ Arietis	5·7	4 41 *e*	81°	5 59 *e*	229°
,, 3 ...	16 Tauri	5·4	11 49 *e*	121	0 32* *m*	225
,, 3 ...	19 Tauri	4·3	11 56 *e*	80	0 49* *m*	265
,, 4 ...	20 Tauri	4·1	0 13 *m*	108	1 0 *m*	238
,, 4 ...	21 Tauri	5·8	0 16 *m*	65	1 6 *m*	281
,, 4 ...	22 Tauri	6·5	0 18 *m*	72	1 10 *m*	274
,, 4 ..	BD+24°562	7·0	0 40 *m*	81	—	—
,, 4 ...	BD+26°731	7·0	11 52 *e*	75	—	—
,, 5 ...	BAC 1648	6·4	4 8 *e*	96	5 25 *e*	246
,, 7 ...	BD+27°1164	6·9	0 54 *m*	135	—	—
,, 7 ...	Wash. 466	7·7	2 55 *m*	120	—	—
,, 8 ...	κ Geminorum	3·6	4 29 *m*	162	4 55 *m*	231
,, 9 ...	Wash. 635	6·6	5 55 *e*	186	—	—
,, 10 ...	BD+11°2217	7·0	10 35 *e*	114	—	—
,, 11 ...	45 Leonis	5·8	1 0 *m*	158	1 54 *m*	273
,, 11 ...	ρ Leonis	3·8	3 30 *m*	81	4 12 *m*	341
,, 11 ...	49 Leonis	5·7	4 46 *m*	142	5 34 *m*	276
,, 12 ...	Wash. 789	6·9	—	—	11 5 *e*	278
,, 14 ...	BD−11°3469	7·0	—	—	4 45 *m*	316
,, 17 ...	Stone 8802	7·0	—	—	3 43 *m*	351

The asterisk indicates the day following that given in the date column.

From New Moon to Full disappearances occur at the Dark Limb, from Full to New reappearances.

Attention is called to the occultation of the Pleiades on March 3rd–4th. Alcyone will escape occultation on this occasion.

SATURN is in quadrature on 2nd, some 5″ N.E. of Aldebaran. Polar semi-diameter 8″. P. is −4°·2; B−26°·6. Ring major axis 42″, minor 19″. The ring is approaching its maximum opening, and projects beyond the poles of the planet. It is interesting to measure the exact amount of overlap. The absolute maximum opening will occur on June 1st, but the Planet will then be too near the Sun to see.

East Elongations of Tethys (every fourth given), $3^d\ 9^h{\cdot}9e$, $11^d\ 11^h{\cdot}2m$, $19^d\ 0^h{\cdot}5m$, $26^d\ 1^h{\cdot}8e$; Dione (every third given),

URANUS is invisible, having been in conjunction with the Sun on January 28th. Very near Jupiter on 4th, $9^h m$.

NEPTUNE was in opposition on January 17th. Semi-diameter 1″. Possessors of small telescopes may easily recognise it by its motion, if they make a sketch map of the stars in the region, and observe it night by night.

ECLIPSE OF THE MOON on morning of March 12th, visible in British Isles. First contact with shadow $2^h\ 42^m m$, angle

TABLE 11. NON-ALGOL STARS.

Star.	Right Ascension.	Declination.	Magnitudes.	Period.	Date of Maximum.
	h. m.	°		d.	
U Urs. Maj.	10 9	+60·4	6·0 to 6·5	irregular	
U Hydrae	10 33	−12·9	4·8 to 6·7	irregular	
R Urs. Maj.	10 39	+69·2	5·9 to 13·1	299	May 9.
V Hydrae	10 47	−20·8	6·5 to 7·7	irregular	
S Leonis	11 6	+ 5·9	9·0 to 13·0	189·5	May 18.
RV Urs. Maj.	11 37	+39·0	8·3 to 14·0	unknown	
S Crateris	11 48	− 7·1	8·4 to 9·5	unknown	
Z Urs. Maj.	11 52	+58·4	6·8 to 8·7	irregular	
R Comae	12 0	+19·3	7·3 to 13·5	361·8	June 4.

Principal Minima of β Lyrae Mar. $4^d\ 11^h\ 50^m e$, $17^d\ 9^h\ 56^m e$, $30^d\ 8^h\ 2^m e$. Period $12^d\ 21^h{\cdot}8$.

Algol minima Mar. $2^d\ 3^h\ 36^m e$, $11^d\ 6^h\ 3^m m$, $14^d\ 2^h\ 52^m m$, $16^d\ 11^h\ 41^m e$, $19^d\ 8^h\ 30^m e$, $22^d\ 5^h\ 19^m e$.

Mira Ceti will reach maximum on March 17th, Mag. 2·0; it will, however, be too near the Sun for convenient observation.

88° from N. to E. Greatest eclipse $4^h\ 13^m m$, magnitude 0·916 (Moon's diameter being 1). Last contact with shadow $5^h\ 44^m m$, angle 330° from N. to E. Moon sets $6^h\ 25^m m$. A smoky appearance will be visible on the East portion of the Moon fully 20^m before first contact with shadow.

DOUBLE STARS AND CLUSTERS.—The tables of these given two years ago are again available, and readers are referred to the corresponding month of two years ago.

VARIABLE STARS.—The list will be restricted to two hours of Right Ascension each month. The stars given in recent months continue to be observable. (See Table 11.)

METEOR SHOWERS (from Mr. Denning's List):—

Date.	Radiant. R.A.	Radiant. Dec.	Remarks.
Mar. 1-4 ...	166°	+ 4°	Slow, bright.
,, 1-14	175	+ 10	Slow.
,, 18 ...	316	+ 76	Slow, bright.
,, 24 ...	161	+ 58	Swift.
,, 27 ...	229	+ 32	Swift, small.
Mar.-May ...	263	+ 62	Rather swift.

NOTES.

ASTRONOMY.

By A. C. D. CROMMELIN, B.A., D.Sc., F.R.A.S.

THE EARTH'S ALBEDO.—The lines of Robert Burns—

O wad some power the giftie gie us
To see oursels as ithers see us—

must have often found an echo in the minds of astronomers. A view of our Earth from external space would, no doubt, be a great help in interpreting the appearances presented by our neighbour worlds, Venus and Mars. There is one method of getting some idea of the Earth's albedo: this is by measuring the intensity of the faint Earth-shine on the crescent Moon, which travels first from Sun to Earth, is reflected from Earth to Moon, whence it is sent back to Earth once more. The difficulties in such a research are manifold. The Earth-shine is blended with the diffused skylight, which arises from the illuminated crescent of the Moon, and the two light sources have to be separated. Further, it is by no means easy to compare the light of the thin lunar crescent with the light of the full Moon, and this is a necessary step in the work. Professor F. W. Very has made a careful research at Westwood Astrophysical Observatory which he describes in *Astron. Nachrichten*, 4696. It would be difficult to summarise his article, so I content myself with quoting his result, which gives an albedo of 0·89 to the Earth. This means that of one hundred rays falling on the Earth (or, rather, on its atmosphere) eighty-nine are reflected back into space, and only eleven absorbed. Since the albedo of the Earth's surface is obviously much lower than this, we conclude that the greater part of the reflection takes place in our upper air, and consequently that comparatively little of the radiant energy that falls on our atmosphere reaches the ground, or is effective in giving us light and heat. Professor Lowell long since explained the rapid melting of the Martian polar cap by the low albedo of that planet and the consequent small absorption in its atmosphere. Hence, in spite of its greater distance from the Sun, the radiant energy that actually reaches its surface may not be very far short of that on the Earth's surface. The cold of the Martian nights must be intense, for the thin atmosphere that presents so slight a screen to incident heat will also present a poor screen against its escape. But the snow cap in summer enjoys perpetual day that lasts for many of our months; and as the white deposit is presumably very shallow, owing to the scarcity of aqueous vapour, its rapid disappearance ceases to be a matter of surprise.

Professor Very quotes in his article the value of the Earth's albedo obtained by MM. Arago and Laugier, viz., 0·6477 for the waxing Moon and 1·132 for the waning one. A value above unity is, of course, impossible, and the large discordance between the two values illustrates the difficulty of the investigation. The mean of the two is 0·89, which agrees exactly with Very's value.

A NEW COMET.—M. Delavan, who found Westphal's Comet, made another discovery in December. It was faint at discovery, but is likely to be an easy telescopic object in February and March. The following elements are by Professor Kobold:

Perihelion ...	1914	March 2·32, Berlin M.T.
Omega ...	7°	40′
Node ...	126°	33′
Inclination ...	13°	5′
Log q.. ...	0·0453	

Ephemeris for 11 p.m.

	R.A. h m s	N.Dec. ° ′	Log r.	Log Δ.
Feb. 5 ...	3 17 50 ...	8 47 ...	0·0717 ...	9·7758
Feb. 13 ...	3 35 31 ...	13 42 ...	0·0576 ...	9·7523
Feb. 21 ...	3 58 59 ...	19 12 ...	0·0484 ...	9·7296
Mar. 1 ...	4 29 43 ...	25 8 ...	0·0448 ...	9·7095

It will be seen that the distances from the Sun and Earth are both diminishing, so that the brightness is likely to increase. According to an American orbit, Perihelion will not be reached till June 28th, and there will be a great increase of light.

MOTIONS IN THE LINE OF SIGHT.—The December number of *Publications of the Astronomical Society of the Pacific* contains some interesting determinations of radial velocity of planetary nebulae. The results for fourteen nebulae range from 60 km. approach to 60 km. recession with reference to the stellar system; there are two with very high velocity. The tenth-magnitude planetary nebula N.G.C. 4846 (R.A. $19^h\ 11^s$, S. Dec. 19° 14′) is receding at 150 km. per second from the Sun; N.G.C. 5873 (R.A. $15^h\ 6^m$, S. Dec. 37° 43′) is approaching at 136 km.

There is also a note of a star with an extraordinarily high radial velocity. The star Lalande 1966 (R.A. $1^h\ 3^m$) has a speed of approach of 325 km. It clearly belongs to the class of "Runaway" stars of which Arcturus and Groombridge 1830 are well-known examples. It has a parallax of 0″·08 (Yale) and a spectrum similar to that of Procyon.

THE ELECTRIC-CELL PHOTOMETER.—Professor Campbell has an article on this subject in the same publication. It consists of a glass bulb, part of whose interior surface is coated with an alkaloid metal, such as potassium or sodium; the bulb contains some rarefied gas. Wires of an electric circuit lead respectively to the coated and uncoated portions of the glass. While the cell is dark no current will cross the gap between the terminals. But if a faint light be thrown on the alkaloid surface the rarefied gas becomes a conductor. The strength of the current passing, as measured by an electrometer, determines the intensity of the illumination. The instrument can be used either for obtaining intensity curves of various parts of the spectrum (including perhaps the accurate location of spectral lines) or for determining star magnitudes. It is stated that the magnitude of a fifth-magnitude star can be determined in two minutes to within ·003 magnitude. Mr. Joel Stebbins, who has become famous by his remarkable results with the selenium photometer, is so struck by the superior accuracy of the new method that he is abandoning his former one in order to give it a trial. In view of his skill and

XUM

experience we may hope for remarkable results in the study of variable stars.

THE LATE MR. FRANKLIN ADAMS'S PHOTOGRAPHS.—The entire set of these photographs, showing the whole heavens from pole to pole down to magnitude 15, are being reproduced at the Royal Observatory. They are two hundred and six in number, each covering about 16° × 16°. Ten plates, showing regions of special interest, have been reproduced in *Memoirs of R.A.S.* (Vol. LX, Part III).

No. I is the large Magellanic cloud, which Mr. Melotte considers to show a spiral structure. The plate brings out the complicated character of the cloud, which contains both clusters and nebulae.

No. II contains α Crucis and η Carinae (with its nebula), and shows remarkable dark lines in the Milky Way. These are also shown in No. III, which shows the startling blackness of the Coal Sack.

No. IV shows our nearest stellar neighbour, α Centauri, which is in a rich region of the Galaxy.

No. VII shows the brightest part of the Galaxy, the star-cloud in Sagittarius and the Trifid nebula. Mr. Melotte says: "The negative shows in the denser parts of the cloud a continuous background of faint stars, the images of which are too close to be separated."

No. X shows the eastern part of Orion, and part of the immense faint spiral nebula that extends from the Great Nebula. A very curious dark bay is shown in the nebula that extends to the south of ζ. All the plates in the Memoir will repay careful study.

SIR D. GILL'S HISTORY OF THE CAPE OBSERVATORY (Third Notice).—The history of our knowledge of the Sun's distance is told in brief in these pages. Passing quickly over early determinations, we come to Newcomb's publication in 1864 of the value 8″·855 for the parallax from observations of Mars in 1862. This gives a distance only half a million miles less than that now adopted. It is well known that the transits of Venus in 1874 and 1882 proved very disappointing, and left the residual uncertainty as large as ever. The next phase was the heliometer method applied to Mars in 1877 by Gill at Ascension, and subsequently to the three minor planets—Iris, Victoria, and Sappho. Four observatories coöperated in the heliometer work, and twenty-two in meridian observation of the comparison stars. The observations were sufficiently accurate to "beat the seven-figure logarithm table," and new ephemerides with eight figures were computed. The resulting parallax from the three planets was 8″·804; this is practically identical with Mr. Hinks's value from Eros 8″·807. The latter is subject to the drawback that, being mainly photographic, there is a possible small error from difference of refraction of Eros and the comparison stars. Probably little further change will be made in the accepted value till the great Eros campaign of 1931, when the planet's distance will be only ·17. It may be hoped that after that the third decimal in the parallax will be nearly free from doubt.

BOTANY.

By PROFESSOR F. CAVERS, D.Sc., F.L.S.

CELL-DIMENSIONS IN DWARF PLANTS.—The question whether differences in size between individuals of the same species, or between different varieties, or between the organs of the same individual, are expressed in differences in the size of the cells, has been investigated statistically by H. Sierp (*Jahrb. f. wiss. Bot.*, Band LIII, 1913), with special reference to dwarf plants. The author points out that a sharp distinction must be drawn between dwarf forms, which owe their dwarfing to unfavourable environmental conditions, and true dwarfs. The former attain the normal size when transferred to favourable conditions, and may be distinguished as "pathologically dwarfed" forms, but the true dwarfs do not thus respond to better conditions, and must be regarded as constitutionally dwarfed. Sierp finds that dwarf forms of the first kind invariably have smaller cells than the normal form; in some cases (*e.g.*, the stinging nettle) the cells are only half as large as those of ordinary individuals. Among true dwarf forms there was, however, great variety in the size of the cells as compared with that of the cells in normal-sized individuals. Thus in some dwarf varieties of potato the cells were invariably smaller than in normal varieties, in a dwarf *Mirabilis jalapa* the cells were just about the normal size, while in a dwarf *Nigella* the cells were actually larger than in the normal plant.

SOIL FUNGI AND HUMUS-FORMATION.—In the last number of "KNOWLEDGE" (p. 28) reference was made to the special fungus flora of the soil. Since that note was written we have received a reprint of an interesting paper by Wanda Daszewska (*Univ. de Genève Inst. Bot.*, 1913), giving descriptions and figures of a large number of fungi isolated from peat, including fourteen new species. The previous workers on soil fungi dealt with ordinary field soil and the leaf mould of woods, but very little was known regarding the fungus population of peat, which is apparently considerable though less abundant than that of woodland soil. The authoress made careful experiments in order to ascertain what action these peat fungi had upon cellulose—an interesting point when we remember that cellulose in the form of cell-walls must constitute a large portion of the organic matter which returns to the soil and is converted into humus. It has long been known that certain bacteria are capable of destroying cellulose, and the same applies to a number of fungi; but we now have the results of special experiments made with peat fungi, showing that these fungi in many cases rapidly destroy cellulose, and it would appear that fungi play a far more important part than bacteria in the cellulose decomposition that goes on in the soil. The brown colour of humus is apparently due, in part at any rate, to the actual colour of the mycelium and spores of the fungi, and to brown and black pigments, as well as to oxidising ferments produced by the soil fungi.

DENITRIFYING MARINE BACTERIA.—In an interesting paper Drew (*Journ. Marine Biol. Assoc.*, 1913) describes observations made on the denitrifying (nitrate-destroying) bacteria of temperate and tropical seas, with particular reference to the power which these bacteria apparently have of precipitating calcium carbonate from soluble calcium salts present in sea-water. According to this author, the vast deposits of chalky mud now being formed off the Bahamas and Florida are being precipitated by bacterial agency, which has probably been an important factor in the formation of chalk and various other kinds of sedimentary rock chiefly or in part composed of calcium carbonate. The denitrifying and lime-precipitating bacteria are much more abundant in warm than in cold seas, and this lends strong support to the interesting theory put forward by Brandt in 1904 to account for the fact that despite the more favourable conditions as to light and warmth in warm seas, the latter contain less abundant minute floating forms (plankton) than the colder seas. Brandt suggested that if the denitrifying bacteria of the sea, like those of the land, develop a strongly disturbing activity at higher temperatures, only a relatively small production of plankton would take place in warm seas on account of the deficiency in nitrates, while in colder seas more nitrates would be at the disposal of the plankton owing to the retardation or suppression of the disturbing (denitrifying) process. A point strongly in favour of this theory is that all the denitrifying bacteria found in temperate seas have a higher temperature optimum than that of their natural environment; but all attempts so far made to correlate quantitative plankton observations with direct

XUM

analysis of the amount of combined nitrogen in sea-water in different localities have failed owing to the difficulty in estimating the nitrate content. However, Drew's observations, until more refined chemical methods can be found for directly testing the matter, appear to form conclusive evidence in favour of Brandt's conjecture.

SEXUAL REPRODUCTION IN YEASTS.—Some years ago it was found that in some of the yeasts (Saccharomycetes), the production of spores is preceded by the conjugation of two cells. This has now been observed in several species, and it strongly supports the view that the yeasts are to be regarded as degenerate forms arising from the Ascomycetes, and not as primitive types of Fungi. This is made still more evident by the fact that in some of the conjugating or sexual yeasts the cells are not simply rounded or ovoid and isolated or united loosely in chains formed by budding, but form a small but definite mycelium. Recently, Konokotina (*Bull. jard. bot. St. Petersburg*, 1913), has described two new species of yeast in which the two cells which conjugate are not alike, as in the conjugating yeasts formerly described, but are differentiated into a large (female) cell and a small (male) cell. One of these heterogamous forms, *Nadsonia elongata*, consists of oval cells which before conjugation become elongated; the two conjugating cells are of different sizes; after conjugation, the female cell sends out a bud-like growth into which pass the fused nuclei and protoplasm, and in this outgrowth the single spore is formed. The second form, *Debaryomyces tyrocola*, is interesting because the conjugating cells may be either alike (homogamous) or unlike (heterogamous), the latter case being the more frequent and showing the same features as in *Nadsonia*.

CHEMISTRY.

By C. AINSWORTH MITCHELL, B.A. (OXON), F.I.C.

PAPER DUST EXPLOSION.—*The Times Engineering Supplement* of December 3rd, 1913, gives an account of a paper dust explosion which took place in a factory at Lille last year. The dust was produced during the grinding of the edges of rolls of paper, and the special chamber in which it collected was emptied from time to time. The explosion occurred while this chamber was being emptied. Samples of the dust were tested at the experimental laboratory at Liévin, and were found to be capable of exploding when mixed with air in a closed space and brought into contact with a flame. The dust was as inflammable as finely powdered coal dust containing thirty per cent. of volatile substances. Numerous cases are on record of explosions due to fine carbonaceous dusts, such as those of flour, starch, and sugar, but this appears to have been the first instance in which paper dust has been the cause of an explosion.

MECHANISM OF OXIDATION PROCESSES.—A theory has been put forward by Dr. H. Wieland that the terms "oxidation" and "reduction" are in reality two ways of representing one process of removal of hydrogen, or "dehydrogenation." In support of this view he cites numerous experiments, and shows that even the biological processes attributed to oxidation are also susceptible of the same interpretation (*Ber. d. Chem. Ges.*, 1913, XLVI, 3327). For example, dextrose (glucose) can be decomposed into carbon dioxide by means of palladium black acting at a low temperature in the presence of oxygen or a quinone compound which is capable of absorbing the liberated hydrogen, and thus preventing it combining with the palladium and rendering it inactive.

In like manner the changes effected by the enzymes, known as oxidases, may also be brought about by palladium black in the presence of quinone, or methylene blue; and since, under such conditions, oxygen is excluded the reactions can only be attributed to processes of dehydrogenation. Alcohol is transformed into acetic acid (vinegar) by the action of specific bacteria, and, as a free supply of atmospheric oxygen is required under the ordinary manufacturing conditions, the process has long been accepted as a typical instance of biological "oxidation." Dr. Wieland, however, shows that the acetic bacteria and the enzyme isolated from them will effect the conversion of alcohol into acetic acid in the presence of methylene blue and in the absence of oxygen.

Again, the reducing enzyme which is present in milk is capable of transforming salicylic aldehyde into salicylic acid in the presence of methylene blue—or, in other words, of acting as an "oxidising" enzyme.

PETROLEUM SPIRIT FROM NATURAL GAS.—The increasing demand for petroleum spirit suitable for the engines of motors has led to numerous attempts to discover fresh sources of supply. During the last three years a large amount of gasoline has been obtained from natural gas in America, and this is employed in admixture with the products from the oil refineries, for lighting and heating purposes, and, to a less extent, as a motor spirit. Its want of homogeneity, however, causes it to give trouble in working, and its commercial success in this respect is therefore still doubtful.

In the last issue of *Petroleum* (1913, IX, 217) an interesting account is given by Dr. Rozanski of the development of this branch of the industry in Galicia. The first attempts to obtain gasoline from natural gas were made there in 1910, when a condensing plant was put up at Hummiska. This was capable of treating six hundred cubic metres of gas in twenty-four hours, and yielded a petroleum spirit with a specific gravity 0·660. The yields were too low, however, for profitable working, and, after about a year's experiment, the work was abandoned. For the same reason another plant, erected last year in Carpathia, was also abandoned.

Much of the natural gas emitted from fissures in the oil-fields is unsuitable for cooling and compression, as, for example, the so-called "dry gas," which contains over forty per cent. of methane. The richest American natural gases yield over one hundred litres of gasoline per one hundred cubic metres, the average yield being about forty to forty-six litres. As compared with this the yields from the Galician gases are very low. A natural gas, composed of sixty per cent. of benzine vapours and forty per cent. of methane, yields, in practice, only about fifteen per cent. of the calculated amount of spirit; but at the present time a yield of even five litres per one hundred cubic metres of gas ought to be profitable, provided that the residual gases were used for heating.

To condense the gases they are first compressed at about three and a half atmospheres, and subsequently at pressures of fourteen to forty-two atmospheres. The cooling is effected by water, ammonia refrigerators, or by the sudden expansion of the compressed gas itself. The resulting petroleum spirit is colourless or light brown, and has a specific gravity of about 0·730 to 0·770. Formerly the American product had a specific gravity of 0·650, or less; but that now prepared has about the same specific gravity as the Galician gasoline. The condensed spirit consists principally of butanes and pentanes, with a little propane and a small amount of hexanes, heptanes, and perhaps nonanes.

ENGINEERING AND METALLURGICAL.

By T. STENHOUSE, B.Sc., A.R.S.M., F.I.C.

NOMENCLATURE OF NON-FERROUS ALLOYS.—The question of a revised nomenclature of non-ferrous alloys is receiving attention both in this country and in America. Besides the purely trade names there are many anomalies in the existing nomenclature, the present names being often misleading, as indicating the composition of particular alloys. Thus, whilst the term "brass" is universally understood to represent a copper-zinc alloy, and "bronze" a copper-tin alloy, "manganese bronze" is not an alloy of copper, tin, and manganese, but is generally a typical "brass" containing under three per cent. of

XUM

manganese. "German silver" is another instance of a misleading name, the components of the alloy being copper, nickel, and zinc. Dr. W. Rosenhain, in this country, has made some suggestions to the Institute of Metals towards a revised nomenclature, and in America, Mr. C. P. Karr contributed a paper on the subject to the American Institute of Metals at the annual meeting held at Chicago in October last. Mr. Karr gives an interesting historical survey, and submits a tentative scheme of classification. He also gives examples of present misnomers, which naturally conflict with the suggested names. Now that the two English-speaking representative bodies are interesting themselves in this question no doubt serious efforts will be made towards a modified nomenclature; but it must not be considered that changes will be easily made. It is probable that many buyers of copper alloys who know that they can get the material they require under a particular name will not easily be persuaded that the material with the new name is "just the same."

EGYPTIAN METAL ANTIQUITIES.—The chemical composition and microstructure of some metal articles made by the ancient Egyptians in the earliest times have been determined by Mr. H. Garland (*Institute of Metals*, 1913, Vol. X, page 329). The object in view was to ascertain to what extent such changes as recrystallisation, diffusion, and growth of crystal grains take place in metals and alloys at atmospheric temperatures during long periods. A knife attributed to the eighteenth dynasty, and therefore about three thousand five hundred years old, was composed of impure copper. The microstructure indicated that the knife had been hammered into shape cold from a cast rod. No appreciable diffusion or crystal growth had taken place during its lifetime. An arrow-tip, also of impure copper, had a similar structure to that of the knife. An ancient Egyptian bronze spatula gave indications of having been annealed after being partially worked, and of having been finally worked cold without further heat treatment. The metal had not recrystallised after the cold work, but was apparently in the same state as when it left the makers' hands. A copper dagger attributed to the first dynasty, and therefore some seven thousand years old, gave evidence of a slight amount of hot work having been done on it; but it had never been properly annealed. No appreciable diffusion had occurred during its lifetime, but some recrystallisation had taken place in the arsenic-rich parts. The author considers from his investigations that the structural changes which take place in such metals and alloys at atmospheric temperatures are trifling.

CORROSION OF IRON.—Dr. J. Newton Friend, who has made a special study of the corrosion of iron and steel, describes, in the October number of *Science Progress*, a number of simple and interesting experiments with iron foil in different saline solutions. Experiments are described also which demonstrate the necessity of having sufficiently large vessels, in carrying out investigations on corrosion, to ensure that immersed samples of metal shall be at all points in contact with solution in the same state as regards dissolved oxygen.

GEOGRAPHY.

By A. STEVENS, M.A., B.Sc.

BIOGEOGRAPHY OF THE TSETSE FLY.—We notice in the *Annales de Géographie* of November a very interesting biogeographical study of the tsetse flies found in French West Africa, by E. Roubaud, with photographs illustrative of the types of habitat of the eight species occurring in the area. He works out the ranges of the species, and recognises important definite differences within species determined by climatic differences, particularly by differences of latitude. For example, *Glossina palpalis* follows the virgin forest in its extension from 4° 30′ N. latitude on the Ivory Coast to about 8° N. latitude, infests the wooded terraces which extend behind to 11° and the less-densely forested borders of these in the French Sudan, where, at certain seasons of the year, it may be encountered up to 14°. Its extension inland is therefore through nearly ten degrees of latitude, and on the coast, where more humid conditions obtain, this is increased by two degrees, the northern limit being at the mouth of the Senegal. The range of climate over this area is considerable. Temperature at the Ivory Coast has a mean of 25° and an amplitude of 20° (Centigrade); in the Sudan the mean is 29° and the amplitude 40°, while the humidity is very much lower than at the coast. It is therefore not surprising that there are geographical races within the species, distinguished by darker colour towards the coast. *G. morsitans* varies similarly with geographical position, and some investigators have been induced by the marked differences to distinguish a subspecies. This variation with climate in species having a wide geographical range is shown to have important correlations when the writer goes on to consider the distribution of trypanosomes and *Glossina* in the region, their biogeographical relations, and their influence on the life of West Africa. Trypanosome diseases are shown to be endemic in certain parts. The infectivity of the tsetses is found to be strikingly different in different places. In some parts trypanosome diseases are unknown or very rare; often such cases as are known are imported. And this is believed to be dependent on the climatic control of the physiology of the salivary glands of *Glossina*.

RUSSIAN WHEAT AND THE BLACK SEA PORTS.—The same journal publishes figures concerning the adjustment of the export trade in wheat of the Black Sea ports, the difficulties under which the trade is carried on, and the measures that are being adopted to remove them. In a country where the methods of agriculture are only beginning to grow out of their primitive condition one does not expect to find a highly organised system of transport. The present one is such that much of the country produce does not reach the ports before the winter has set in, with the result that a great deal of it has deteriorated very badly, and the price realised falls enormously. The matter is important in these days when the wheat supply of the world is a matter which is providing material for some thought, and fortunately the Russian Government are taking steps to reduce the waste, while their action is hailed in the country with enthusiasm. Elevators and stores on the American model are under construction in agricultural areas in Europe and Asia, and it is expected that in five years there will be a supply of depots sufficient to relieve the present need for cleaning, fanning, and classifying the grain. Control will be exercised by a special department under the Minister of Finance, and the officials in charge of the stations will act as intermediaries between the producer and the merchant. There is no want in the number or size of the ports which handle the grain, but it is interesting to note that Odessa has lost its pre-eminence in the trade. Last year it came after Nicolaev and Rostov, but the statistics of several years back put it further behind. Wheat, moreover, is by no means the cereal most largely exported. Barley comes first; and oats, maize, and rye are shipped in quantities.

GEOLOGY.

By G. W. TYRRELL, A.R.C.Sc., F.G.S.

THE ASCENT OF LAVA.—Why does lava rise from below towards the Earth's surface? The question is raised by F. A. Perrett in a paper on "The Ascent of Lava" (*American Journal of Science*, December, 1913). The initial direction of movement of the lava, as it seeks to spread from the intercrustal reservoir, is, no doubt, determined by the lesser pressures which prevail toward the surface. Its continued ascent, often in a narrow cylindrical tube, is a perplexing problem. As Perrett points out, such upward

progression represents work against gravity, and necessitates the perforation of successive strata. Furthermore, it takes place at the point farthest removed from the heat reservoir and where the actual contact-pressure is least.

In common with Professor R. A. Daly, Mr. Perrett concludes that the chief agent concerned in the upward progression of the lava column is magmatic gas. Every magma is saturated with gas, which, when disengaged, tends to collect at the top of the lava column. In this position it is under enormous pressure, which tends to augment its already great heat, and gives it the power of acting as an efficient fluxing agent. The volcanic pipe is therefore considered to have been drilled by a gas-fluxing process essentially similar to that of an ordinary blowpipe. When the lava eventually attains the surface and initiates a volcano, a further problem arises as to the continuance of the supply of heat necessary to its activity. The whole question of volcanic activity is beset with similar interesting problems, which are being attacked with great energy by such workers as Professor R. A. Daly, A. Brün, and F. A. Perrett.

SATURATED AND UNSATURATED IGNEOUS ROCKS.—Professor S. J. Shand points out and emphasises a distinction in the behaviour and occurrence of igneous rock minerals with respect to free silica (*Geological Magazine*, November, 1913). About half of these are capable of forming in the presence of free silica, and are associated in igneous rocks with quartz and tridymite. The remaining rock-forming minerals do not appear along with quartz, save in certain exceptional cases. The former set are the more highly saturated, the latter the less highly saturated compounds of their respective metallic elements, and are said to be saturated or unsaturated respectively with regard to silica. The saturated minerals have taken up their full complement of silica, whereas the unsaturated have not. Familiar examples are orthoclase and albite amongst the saturated, and leucite and nepheline amongst the unsaturated group.

Professor Shand makes a distinction between igneous rocks according as to whether they are composed of saturated or unsaturated minerals. The groups thus formed correspond largely with those now known as calcic and alkalic. The unsaturated or alkaline rocks have in general a much greater action on the rocks they invade than have the saturated rocks, since they are capable of entering into chemical combination with the silica of the invaded rock masses. As a consequence of the chemical activity of an under-saturated magma a greater variation, both chemical and mineralogical, would be expected in an under-saturated than in a saturated igneous complex. This deduction is confirmed by the well-known variable character of alkaline rocks.

Professor Shand thinks that the distinction may prove of use in classification. It may perhaps be pointed out that it is recognised in the American Quantitative Classification by the ratio which determines the *orders* in that system. This ratio contrasts the amount of quartz *or* lenads (felspathoids) with that of felspars. The rocks falling in the orders determined by the quartz-felspar ratio are the saturated types; those falling in the orders determined by the lenad-felspar ratio are the under-saturated types.

METEOROLOGY.

By WILLIAM MARRIOTT, F.R.MET.SOC.

A WATERSPOUT AT CLOSE RANGE.—Captain H. C. Hansen, of the Norwegian ship "Majorka," on October 2nd, 1913, when in latitude 45° 37′ N. and longitude 14° 0′ W., was fortunate enough to observe a waterspout at close range. He has furnished to the United States Hydrographic Office the following interesting account of its formation.

"At 7.30 a.m. a whirlwind was seen about an eighth of a mile to the leeward of the ship, which was headed north-west, and when it became apparent that it was an incipient waterspout the wheel was put hard to starboard and the ship was gotten off toward the west-south-west, and immediately the whirlwind passed the ship's stern in a north-south direction at a distance of about ten feet. It had taken the form of a thin spout, which increased in diameter and became denser. It was accompanied by a strong puff of wind, a heavy downpour of rain, and roaring sound.

"Within a circle of about twenty-five feet in circumference the water was in a violent uproar similar to a large waterfall. The spout grew until it was about five feet in diameter, and had a lighter appearance in the centre about three feet in diameter, in which the water streamed up, and on each side of this a darker band about one foot in breadth, in which the water was descending. The motion in both the upward and downward currents was very rapid. The spout lifted and bent forward about half-way between the cloud at the top and the surface of the water. At that time it was about one thousand five hundred feet from the ship. The duration of the spout from the beginning of the formation until it broke loose from the surface was about ten minutes.

"The barometer was 30·10 in. immediately before the whirlwind was seen and stood at 30·16 in. immediately after the passage of the spout. There was no marked change in temperature, but one could notice an odour of sulphur in the air which was dissipated when the wind shifted to north-north-east."

THE METEOROLOGICAL CONDITIONS OF AN ICE-SHEET.—At the December meeting of the Royal Meteorological Society Mr. C. E. P. Brooks read a paper on "The Meteorological Conditions of an Ice Sheet and their bearing on the Desiccation of the Globe." As the regions occupied by extensive ice-sheets at the present day, viz., Antarctica and Greenland, are the centres of permanent high-pressure areas, with slight precipitation, he infers that the regions occupied by similar ice-sheets in the Glacial period were likewise occupied by permanent anticyclones. The maximum extent of glaciation occurred at about the same time in different regions of the globe, and also coincided with the maximum of the pluvial period, or period of greater rainfall than the present, in the unglaciated regions. But a general decrease in temperature should lead to a decrease, not an increase, in the amount of evaporation, and hence of precipitation. Mr. Brooks says that the explanation of the paradox lies in the different distribution of the precipitation. Various causes tended to minimise the effect of the fall of temperature in decreasing evaporation; thus, while the total precipitation over the globe may have been somewhat less than now, so little of it fell over the ice-sheets that the remainder, falling upon the unglaciated areas, rendered these considerably moister than now. Since the culmination of the Ice Age desiccation has progressed with the retreat of the ice. Slight reversals have taken place; an example is the period, cold in the north, moist in the south, from the ninth to the thirteenth century.

DIURNAL VARIATION IN THE AMOUNT OF RAINFALL.—In the "Meteorological Notes" for December, 1913, reference was made to the duration of rainfall, and particulars were given of the monthly *duration* in hours for several stations in various parts of the country during 1912.

Comparatively little information is available as to the diurnal variation of the *amount* of rainfall in the British Isles, as the hourly amounts are rarely tabulated. The Meteorological Office has, however, for many years past published such tabulations in the *Hourly Readings* from the records of its four observatories. The annual average hourly amounts, as recorded at these observatories for the forty years 1871–1910, are given in Table 12. In this table has also been included similar data for Southport, but the averages are only for the ten-year period 1902–1911.

XUM

TABLE 12.

DIURNAL VARIATION IN THE AMOUNT OF RAINFALL IN INCHES.

Observatories.	A.M.											*Noon.*
	1	2	3	4	5	6	7	8	9	10	11	
	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.
Valencia	2·49	2·44	2·60	2·63	2·64	2·54	2·62	2·52	2·48	2·19	1·99	2·19
Aberdeen ...	1·18	1·22	1·22	1·37	1·38	1·38	1·37	1·34	1·32	3·16	1·07	1·16
Falmouth ...	2·04	2·07	2·22	2·15	2·01	2·08	1·98	2·07	1·93	1·90	1·54	1·71
Kew	·95	·99	·98	·98	1·07	·98	·98	·92	·93	·95	·86	1·01
Southport ...	1·37	1·41	1·26	1·52	1·53	1·40	1·35	1·24	1·28	1·17	1·07	1·16
Observatories.	P.M.											*Midnight.*
	1	2	3	4	5	6	7	8	9	10	11	
	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.
Valencia... ...	2·04	2·08	2·10	2·10	2·23	2·29	2·31	2·34	2·28	2·32	2·39	2·43
Aberdeen ...	1·31	1·27	1·33	1·35	1·41	1·37	1·24	1·21	1·26	1·23	1·21	1·18
Falmouth ...	1·70	1·79	1·73	1·71	1·78	1·81	1·80	1·81	1·82	1·87	1·86	1·98
Kew	1·08	1·05	1·17	1·15	1·18	1·05	1·04	1·01	·99	·92	·90	·91
Southport ...	1·22	1·34	1·40	1·38	1·32	1·39	1·36	1·27	1·18	1·22	1·39	1·40

The average yearly total of the rainfall at each of the observatories for the periods in question is: Valencia, 56·24 in.; Aberdeen, 30·74 in.; Falmouth, 45·36 in.; Kew, 24·05 in.; and Southport, 31·63 in.

At the west-coast stations, viz., Valencia, Falmouth, and Southport, the principal maximum occurs in the early morning hours about 3–5 a.m., while at Aberdeen, which is on the east coast, and at Kew, which is more inland, the maximum takes place in the afternoon at 5 p.m. It is very remarkable that the minimum at all the above places should occur at 11 a.m.

In connection with this it may be interesting to refer to the old weather proverb:

Rain before seven—
Fair before eleven.

An explanation may possibly be found in the tendency of small secondary disturbances to form at particular hours, while during the winter months there is a marked tendency of large cyclones to come in from the Atlantic with increased intensity during the night.

WIND GUSTS.—At the meeting of the Aëronautical Society on January 7th Dr. W. N. Shaw, F.R.S., gave a lecture on "Wind Gusts and the Structure of Aërial Disturbances." He stated that gusts are the expression of turbulent motion in the atmosphere. They are most conspicuous near the surface, and may be attributed to the effect of moving air, which change the uniform motion of a steady current into pulsating motion with eddies. The most fully developed form of eddy-motion in the atmosphere is the cliff eddy. In other cases the vortices rapidly disintegrate, and so far the eddy-motion has not lent itself to numerical measurement. Eddy-motion is found in persistent forms, and can arise spontaneously in the free atmosphere, probably in consequence of thermal convection. The elements of eddy-motion to be found in a line squall may give rise to temporary eddies with a vertical axis. Local convection in the atmosphere must inevitably give rise to local differences of pressure, and hence to local winds, which are shown in anemometers as recurring squalls. Consequently the causes and origin of recurring squalls should be looked for in the thermal changes due to local convection.

MICROSCOPY.

By F.R.M.S.

THE STRIDULATING ORGANS OF INSECTS.—The methods by which some insects produce sounds which are audible to human ears are of considerable interest to the microscopist, since, having no lungs like animals, the noises are the results of vibrations caused by mechanical means, and the apparatus employed in the production of such sounds is usually visible under the microscope. Insects probably make other sounds which, though inaudible to us, are well understood by their own species, and we are perhaps in error in classing them amongst "dumb creatures." In the case of the grasshoppers and the crickets the noise is generally caused by raising the tegmina above the back and rapidly rubbing their inner surfaces together, the one on the left carrying a row of hard bead-like teeth and the other a similar row ranged along the edge of a tightly stretched membrane of circular shape, which doubtless acts as a resonator. In many of the cricket tribe this tympanic membrane is found on both tegmina. When these rows of teeth are in contact, the rapid passage of one along the other produces vibrations which, though of high pitch, are within the compass of our organs of hearing. In the *Pneumorides*, however, the arrangement is different, there being a series of chitinous ridges on both sides of the insect's abdomen ranged across a curved tapering tube closed at its large end by a resonant membrane. These ridges are acted upon by a row of small teeth on the inner side of the femur of each hind-leg, arched in shape over a space closed in on both sides by a tense membrane. In this case, the ridges being fewer in number and wider apart, the number of vibrations per second is less than those produced by the crickets and the grasshoppers, a much lower tone being the obvious result. This has been described by one observer as being "like the overtone produced by blowing too hard through a child's penny trumpet," and the whole body being inflated and acting as a resonator the sound is heard on a still night at a distance of nearly half a mile. The females of this genus, being unable to fly, are provided with remark-

able auditory organs, which are no doubt attuned to vibrate in sympathy with the tones produced by the males. In some of the ants a very interesting stridulating organ may be seen on the lower portion of the second segment of the abdomen, consisting of many rows of fine elevations which are acted upon by the incurved edge of the preceding segment, and produce a very distinct squeak when in operation. R. T. L.

THE ROYAL MICROSCOPICAL SOCIETY.—The annual meeting of the Royal Microscopical Society was held at 20, Hanover Square, on Wednesday, January 21st. The report of the council on the year's work and the treasurer's accounts were read, and disclosed a highly satisfactory condition of affairs. After the election of officers for the ensuing year the president, Professor G. Sims Woodhead, gave his presidential address on "The Microscope in Medicine." It is impossible in the brief space at our disposal to give a detailed report, but even well-informed fellows must have been astonished at the all-important part the microscope has played in the development of medical science.

The far-reaching deductions made by observers such as Malpighi and Leeuwenhoek with very inadequate means in bygone centuries, and the work of Pasteur, who, like Leeuwenhoek, was a layman, were reviewed. The fuller understanding of function by the examination of structure and the ability to determine the malignant and benign tumour by microscopic examination were described. Then followed details of the patient investigation which established the cause of malaria to be the Anopheles mosquito, whereby liability to this disease has been immensely reduced, and the experiments which led to the discovery that the flea of the rat was the cause of bubonic plague, in consequence of which it may be said with certainty that, provided there is cleanliness, and the absence of rats is ensured, no scourge of bubonic plague need ever occur again—these and many other diseases which have from time immemorial menaced the life of the resident in the uttermost parts of the earth have been understood, and cause and effect revealed, by means of the microscope. These notes merely touch the fringe of the subject mentioned in this masterly address, which deserves to be read in its entirety in the Society's Journal by all who are interested in knowing what has been done for the benefit of humanity at large by the use of the microscope.

QUEKETT MICROSCOPICAL CLUB.—At a meeting held on December 23rd, 1913, Mr. B. M. Draper read a paper on "A Live Box for the Observation of Insects and Similar Objects." This was intended for the display, under the lowest powers, of large creatures such as house-flies. It is, in effect, a transparent chamber of the shape and size of a small pill-box. The body is made of a short piece of glass tube, say, one-third of an inch deep by two-thirds of an inch diameter. This is cemented to a three-inch by a one-inch slip. The lid is a circular piece of glass with three short pins fixed at equal distances round the edge. These project downwards so as to clasp the body when the lid is in position. For the illumination of objects in this box, or any large opaque object, an ordinary concave microscope mirror fitted to the end of a jointed arm and giving universal movement, attached to the upper side of the stage and used with lamp and bull's-eye, is very satisfactory.

Mr. B. M. Draper also discussed dark-ground illumination with the Greenhough binocular microscope. Trial of various patterns of patch stops proved the best form to be two small circular patches placed side by side in the same plane and close together. The two patches must be arranged opposite the two front lenses of the twin-objectives.

Mr. E. M. Nelson, F.R.M.S., contributed a paper "On "*Amphipleura Lindheimeri*." The recent discovery was mentioned of a coarser form of this well-known test, having but 67,000 striae per inch as against 77,000 in the old form. It is therefore necessary to distinguish between these two forms when quoting *Lindheimeri* as a test. The new form can be recognised by its very long terminal nodules, a terminal nodule being one-third of the whole length of the valve. In the old form it is only one-fifth. The length-breadth ratio in the new form is 7:5; in the old, 8:5.

PHOTOGRAPHY.

By EDGAR SENIOR.

TO CONVERT A PHOTOGRAPH INTO A LINE DRAWING.—In many instances where a photograph is employed for illustration purposes it is only a portion that is really required, and an advantage would be gained by having this in outline, so that a block could be prepared that would print well on the same paper as the printed matter. In order to produce a result which would be suitable for the purpose a bromide print from the negative is first made, greyer in tone than usual, and on a smooth paper that will allow of being readily worked upon. The print is fixed, washed, and dried, when it is ready for working upon, this being done with a waterproof ink applied with a steel pen in such a manner that the chief features in the photograph which are required are translated into lines, which are more or less thick. When the drawing is completed the print which has been worked upon is placed in a dish, and a solution of mercuric chloride of the following strength poured over it :—

Mercuric chloride	1 ounce
Water	16 ounces
Strong hydrochloric acid ...	½ drachm

The print rapidly bleaches in this solution, leaving the ink lines intact upon a white ground, and after washing and drying it is ready for copying, for which purpose a slow gelatine plate and a hydroquinone developer may be used, the particular formula for the developer which has been found to give very good results being as follows :—

Hydroquinone	4 grains
Sodium sulphite	24 ,,
Potassium bromide	1 grain
Sodium carbonate	36 grains
Potassium carbonate	36 ,,
Water to	1 ounce

This developer will be found to yield great density, combined with clear glass lines in nearly all cases, unless the plate be greatly over-exposed. Another method that may be employed in place of the bromide paper for making the initial print upon consists in sensitising paper with a solution of ammonio-citrate of iron, and, after printing from the negative upon it, developing with a weak solution of potassium ferricyanide (red prussiate of potash). This gives a blue image, which does not require to be removed after it has been worked upon with the waterproof ink prior to copying, especially if a collodion plate be used, which can afterwards be treated in the necessary manner to obtain the required contrast. Should the blue colour, however, be too strong it can be reduced by prolonged washing; or, if it be desired to remove it altogether, this may be accomplished by the use of an alcoholic solution of potassium oxalate, or by the use of water made alkaline with a little caustic potash. For rapid work with the bleach-out process it is preferable to use a saturated alcoholic solution of mercuric chloride, and when the bleaching is complete to rinse the print with some clean spirit and then dry. Not only is time gained by adopting this method, but fine lines are less liable to become blurred. Of other methods for bleaching that with copper bromide is to be recommended. For this purpose a solution is made as follows :—

Copper sulphate	50 grains
Potassium bromide	30 ,,
Water	2 ounces

The print, after being bleached in the above, is well rinsed and then dried. It is always advisable that prints intended for drawing upon should be attached while still damp to

XUM

a sheet of glass by means of a little gum at the edges, as they will then dry perfectly flat and be in a much better condition for working upon.

PHYSICS.

By A. C. G. EGERTON, B.Sc.

X-RAYS.—When X-rays fall on a substance they give rise, not only to "scattered" radiation of much the same type as the original rays, but also to "secondary" rays of definite kind depending on the nature of the substance. The nature of the rays varies according to their penetrating power, which is measured by their absorption in aluminium. A "hard" ray penetrates a greater thickness of aluminium than a "soft" ray. The penetrating power, or "hardness," of a scattered radiation depends on the hardness of the incident radiation; but it is not usually quite so penetrating as the incident radiation. The softer rays are scattered more than the hard rays. About a tenth of the energy, abstracted from rays of average hardness passing through a thin material, is converted into scattered radiation. The secondary radiation, on the other hand, is homogeneous in character; it is not composed of rays of varying hardness, but for the same metal the penetrating power is perfectly definite. The hardness of these secondary rays depends on the atomic weight of the metal on which the primary beam of X-rays falls. The secondary radiation is not marked until metals of atomic weight above 40 are employed; the energy of the emergent radiation from substances with smaller atomic weight than 40 is chiefly composed of scattered radiation. The ratio of the strength or intensity of the secondary radiation to the incident radiation increases as the hardness of the latter approaches that of the secondary radiation characteristic of the metal; but if the hardness of the primary beam is less than that characteristic of the metal the secondary rays will not be excited at all. Thus rays characteristic of zinc excite those of copper; but copper rays would not excite zinc rays. For the heavier elements there is another set of secondary rays emitted; rays much softer relatively to the other secondary rays which the element emits. For the lighter elements it is possible that this second set of secondary rays is formed, but being so soft they escape detection, and are absorbed before they reach the measuring instrument. On the other hand, the secondary radiation of the first type emitted by very heavy elements, such as bismuth, have not been obtained, because it is necessary to use a primary beam harder than the secondary rays of bismuth, and this is not possible owing to the limited potential difference which can be applied to an X-ray tube. Consequently only the secondary radiation of the second type has been observed. It is found that the radiation of the first type (the "K" series) from an element of atomic weight W' is connected with that of the second softer type (the "L" series) from an element of atomic weight W by the relation $W' = \frac{1}{2}(W-50)$.

When light falls on certain substances they fluoresce; that is to say, they give out light of a particular colour characteristic of the substance, *e.g.*, quinine, petroleum, eosine, rhodamine. These secondary X-rays have therefore been termed fluorescent radiations.

Besides these radiations X-rays excite other kinds of rays when they fall on a substance. These are secondary β-rays; rays of the same nature as cathode rays obtained in vacuum tubes, or the β-rays from radium; they are negatively charged.

The nature of the secondary β-rays so formed is analogous to the different types of X-radiation to which a beam of X-rays gives rise; but the velocity is used as the determining factor, instead of the hardness, as with the X-radiation. The rays have different velocities, but the greater number have a velocity near the maximum velocity which is determined by the quality of the exciting X-rays, and there is a definite secondary β-radiation for any particular element. It is thus the fastest β-rays emitted from any substance on which copper X-rays fall which would be termed the "copper secondary β-rays."

The X-rays do not by any means cause every atom through which they pass to emit a β-ray; not more than one millionth of them are so affected. The X-rays, as is well known, are excited by the stopping of cathode rays by material substances. It is found that the fastest cathode rays which cause the emission of a certain beam of X-rays have the same velocity as the fastest secondary β-rays, which can be produced by those X-rays; and also the following fact is of importance, viz., that the intensity of the X-rays produced from an anticathode of a particular metal by kathode rays increases very rapidly as the velocity of those kathode rays becomes sufficiently large to give the characteristic radiation of that metal.

Thus kathode rays give rise to X-rays, X-rays to scattered X-rays, secondary X-rays and secondary β-rays, and secondary β-rays excite other X-rays, and so on. The energy of the radiation is divided up among these various types of ray. The absorption of X-rays increases with the atomic weight of the substance through which they pass, and with the softness of the rays. But if the rays are just of the hardness to excite secondary X- and β-rays in the substance the absorption increases very considerably, because so much of the energy of the primary beam is utilised in order to excite the radiation characteristic of the substance. This is somewhat similar to the absorption bands obtained with fluorescent substances.

In a way, then, the elements possess properties, as regards X-rays, analogous to their characteristic spectra for light; but the properties are simpler: they give out only two definite types of rays, instead of a number of different wave-lengths of light. The X-rays affect the very internals of the atom; light only affects the external portions of an atom.

ZOÖLOGY.

By PROFESSOR J. ARTHUR THOMSON, M.A., LL.D.

EFFECT OF INTOXICATING MALE PARENT.—Dr. Charles R. Stockard has for three years made experiments in intoxicating male guinea-pigs by inhalation of alcohol (which does not spoil their stomach), and has reached the very important conclusion (see *American Naturalist*, November, 1913) that an alcoholised male guinea-pig almost invariably begets defective offspring, even when mated with a vigorous normal female. The effects were manifest in the second-generation animals as well. "The poison injures the cells and tissues of the body, the germ-cells as well as other cells, and the offspring derived from the weakened or affected germ-cells have all the cells of their bodies defective."

DEEP-WATER FISHES ON THE PARIS MARKET.—J. Pellegrin calls attention to the not infrequent occurrence on the Paris market of rare fishes from deep water—two hundred metres or so. It seems that the fishermen are going further afield and working at greater depths. Among the forms noted are the following: *Beryx decadactylus*, *Beryx splendens*, *Hoplostethus mediterraneus*, *Dentex macrophthalmus*, the archaic Bramid *Pterycombus brama*, and *Macrurus atlanticus*. Portions of the very rare *Parazenopsis conchifer* were also obtained. The "consommation parisienne" seems to be becoming more exquisite than ever.

THE GOLDEN-EIGHT MOTH.—Charles Nicholson calls attention to the remarkable history of this moth (*Plusia moneta*) in Britain. Its first appearance seems to have been in 1857; a great invasion occurred in 1890; since then it has spread over England. During the last half-century or so it has diffused persistently westward and southward from its Russian headquarters. The name "golden-eight" refers to the markings on the golden-grey wings. When the moth is at rest it puts on a mantle of

invisibility. "It strongly resembles a dead and dry leaf still attached to the stem. The front legs are stretched out straight in front of the head at a right angle to the axis of the body, the second pair of legs being pressed close to the body, while the last pair just hold to the support, almost, or quite, covered by the tips of the forewings which just touch beyond the body, the moth appearing to be clinging to its support by the front legs and wings only. It falls to the ground when touched."

MYRMECOPHILOUS BEETLES.—Karl Jordan has made an interesting study of the glands of Lomechusa and Atemeles and other related beetles which live as guests in ants' nests. Numerous unicellular glands on the sides of the abdomen produce the secretion that the ants lick with evident gusto. But there are also numerous offensive glands, common to other beetles of the same sub-family Aleocharinae, which are not myrmecophilous. The secretion of these offensive glands has an odour like that of amyl-acetate, or methyl-heptenon; and it has, like these substances, a stupefying effect on the ants. It is used against stranger ants, or against the hosts themselves when they are troublesome. The possession of the offensive glands gives the beetles a certain standing, so to speak, but it is on the possession of the palatable secretion that the myrmecophilous partnership depends.

AUTOTOMY IN *LINCKIA*.—Hubert Lyman Clark has studied the extraordinary regenerative capacity of *Linckia guildingii*, a starfish common on the reefs of Jamaica. Rays, severed at some distance from the disc, give rise to new discs and rays, just as well as those which separate close to the disc. Arms are thrown off at irregular intervals for a long period, if not throughout life. In the autotomously severed rays growth continues, especially at the proximal end, where new rays soon begin to appear, radiating out from a new mouth. Growth of the new rays is much more rapid than that of the parent ray, and they may ultimately approximate to it in size. The conclusion come to is that the autotomy is an asexual method of reproduction of prime importance.

REPRODUCTIVITY.—Dr. Th. Mortensen calls attention to the extraordinary fecundity of the starfish, *Luidia ciliaris*, which is well known in our seas. The beautiful red ovaries are arranged in a double series in each arm—three hundred in an arm thirty centimetres long. As the species is seven-rayed a complete female of that size, which is nearly the average, has two thousand one hundred ovaries. In one ovary there are at least three hundred thousand eggs, probably nearer half a million. As the ovaries are smaller towards the tip of the arm it may be just to take the mean number of eggs per ovary at one hundred thousand, and the number of ovaries may be reduced to two thousand. This gives the number of eggs in a grown female at no fewer than two hundred millions. Yet the larvae are relatively rare at Plymouth, and the adults are far from common. "What a waste of eggs must here take place!"

CRYPTODROMIA AND ITS SPONGE.—Zoölogists are well aware that the little crabs of the genus Cryptodromia are in the habit of masking themselves with a piece of sponge or ascidian, or the like. R. P. Cowles has recently watched the whole process of sponge-cutting. The naked crab (*Cryptodromia tuberculata*, in the Philippines) cuts a groove on an encrusting greyish sponge, works its way under it, and dislodges it. In a short time the ragged edges of the sponge shield grow smooth and neat. The cutting is done with the forceps, but the dislodged piece is caught hold of and carried by the last pair of legs. "It is a surprise to the collector when, on turning over a rock covered with large and small patches, he sees some of the smaller patches suddenly become animated and crawl away. Another surprise is in store for him when he picks up one of these small patches and finds it to be the cover of a crab carefully hollowed out so as to fit the outline of the carapace and tightly held in place by the last pair of legs, whose dactyli (terminal joints) are hooked into the inturned rim."

REVIEWS.

BOTANY.

Researches on Irritability of Plants.—By J. C. BOSE. 376 pages. 190 illustrations. 9-in. × 6-in.

(Longmans, Green & Co. Price 7/6 net.)

The author has, in his more recent researches on irritability in plants, used new methods by which the scope of investigation has been enlarged and a higher degree of accuracy secured. In the present work the various excitatory phenomena of plants have been investigated by means of mechanical response under the action of a testing stimulus. The author gives, if anything, too much detail regarding his own experiments; though there is a summary at the end of each chapter, it is rather difficult for the reader to get hold of any general principles concerning plant irritability. In a work of this scope one naturally expects to find references to the work of others than the writer himself, but, since practically no such references are given, we are presumably to infer that somehow or other the rather extensive, though specialised, field covered by the author was entirely overlooked by plant physiologists until he began his researches. The main thesis of the book is that hardly a single phenomenon of irritability is observable in the animal which is not also found in the plant, and that the various manifestations of irritability in the plant are identical with those in the animal.

F. C.

Makers of British Botany: A Collection of Biographies by Living Botanists.—Edited by F. W. OLIVER. 332 pages. 28 illustrations. 8¾-in. × 5½-in.

(The Cambridge University Press. Price 9/- net.)

This volume represents in somewhat expanded form a course of lectures given at University College, London, in 1911, by various botanists, the lecturer in each case being either a worker in the same field as, or in some other way having a special qualification to deal with, his allotted subject. The period covered by the lives of the British botanists here dealt with is nearly three hundred years, and the subjects of the biographies given are Morison, Ray, Grew, Hales, Hill, Brown, Sir William Hooker, Henslow, Lindley, Griffith, Harvey, Berkeley, Gilbert, Williamson, Marshall Ward, the Edinburgh Professors from 1670 to 1887, and Sir Joseph Hooker. All the biographic sketches included in this volume are exceedingly readable and interesting, showing fine insight into and sympathy with the labours of those who have been so largely responsible for the building up of botanical science in general and of the British school of botany in particular. In several cases it is obvious that the writer has done a considerable amount of literary research in fulfilling his allotted task, and in this book we find many interesting details not given in any other history of botany. Everyone interested in the progress of botany in this country should read these interesting essays.

F. C.

XUM

ECONOMICS.

The Standard of Value.—By WILLIAM LEIGHTON JORDON. 292 pages. 8½-in. × 5½in.

(Simpkin, Marshall, Hamilton, Kent & Co. Price 7/6 net.)

The fact that this book is now in its eighth edition may be taken as some indication of the demand there is for it. The work is a very interesting statement of the case for bimetallism, and, as the author points out in his preface, although the large supplies of gold recently obtained from South Africa "seemed likely to take from the double-standard question the position of practical importance" which it held during the thirty years previous to the publication of the seventh edition of his book (in 1896), "the currency legislation of the Indian Government has made it again a burning question."

Mr. Jordon bases his main argument for bimetallism on the ground that if a debt is contracted in silver it is obviously unfair to the debtor to compel him to pay in gold. Now the National Debt was mainly contracted in silver; and in the same manner as it would be unjust to the creditor to allow the debt to be discharged in copper, so is it unjust to the debtor to force him to pay in gold. Moreover, as the value of the silver pound has decreased, and that of the gold pound increased, compared one with the other, consequent upon the establishment of the monometallic standard, it follows that the National Debt has been artificially augmented in amount in a corresponding ratio.

Mr. Jordon is in favour of free coinage of both silver and gold; free, that is, in the sense of unlimited, not in the sense of gratuitous; and he is of the opinion that, if such policy cannot be agreed upon by the nations of financial importance by treaty, England would do well to take the lead. Whatever may be said for or against these views, they are certainly worthy of careful consideration by economists. Mr. Jordon's book, however, loses a good deal of force, I think, through the fact that it consists of a number of papers and letters, written at various times and on various occasions, which appear to have been revised mainly by the addition of footnotes. There is consequently not a little overlapping, and the various chapters do not, as one would wish, present the argument in a consecutive form. I would suggest that Mr. Jordon, if he contemplate a further edition, should rewrite the book from beginning to end in a methodical manner.

H. S. REDGROVE.

FORESTRY.

The Theory and Practice of Working Plans (Forest Organisation).—By A. B. RECKNAGEL. 235 pages. 8 illustrations. 9-in. × 6-in.

(Chapman & Hall. Price 8/6 net.)

This book will be of the utmost value to all who are interested in the methods of forest management, since it contains in an extremely clear and condensed form the results of the author's experience, both in Europe and America, in forestry work. After describing the various methods that have been proposed for successful forestry, the author gives an interesting account of the forest areas of France, Germany, and Austria, with notes on the methods of management adopted in these countries. At the end of the book there are set out numerous schedules which the author suggests should be used for the recording of forestry data.

F. C.

The Important Timber Trees of the United States.—By S. B. ELLIOTT. 382 pages. 46 illustrations. 8¼-in. × 5¼-in.

(Constable & Co. Price 10/6 net.)

This book is divided into two parts, the first dealing with the growth and growing of trees in general, the second with the various types of forest tree grown in America (including, of course, most of those grown in Europe too). In the first section the author treats the general principles of forestry in a very interesting manner, keeping the physiology and ecology of trees well in view; while in the second section we find many interesting notes on the chief forest trees of the United States, including both the indigenous species and those that have been introduced from Europe. The book is beautifully illustrated, and is produced at a very moderate price.

F. C.

GILBERT WHITE.

Bulletin of the British Ornithologists' Club.—By W. H. MULLENS. No. CXC. 27 pages. 8½-in. × 5½-in.

(Witherby & Co. Price 2/6 net.)

Every book, article, or reference which brings before Englishmen the importance, value, and far-reaching effects of Gilbert White's work should receive a hearty greeting; and therefore Mr. Mullens's labour of love must receive from us a warm welcome, as it will be sure to show many ornithologists what they owe to the curate of Selborne. They will learn from the second part something of the life of the naturalist from the pen of one who, perhaps more than anyone else living, has studied White's work, collected his letters, read his journals, and lectured upon his home in Selborne and his visits to Sussex. The first part, which is a guide to Selborne, was written, as was the other paper, in connection with a proposed expedition of the British Ornithologists' Club to Selborne (to celebrate its coming of age), but which fell through owing to the death of Dr. Sclater. It will not, however, have been prepared in vain, for it will lead to many private visits, we should imagine, to the now world-famous village.

W. M. W.

NATURAL HISTORY.

Birds of a County Palatine.—By ALFRED TAYLOR. 148 pages. 148 illustrations. 12-in. × 9½-in.

(The "Wild Life" Publishing Co. Price 16/- net.)

It seems as if the interest aroused by birds can never be exhausted, and the naturalist who is at the same time an expert photographer, besides enjoying all the delights of the chase without any qualms of conscience, can impart to others no small share of his pleasure from his pictures. Mr. Alfred Taylor, upon whose work we have the pleasure of commenting, in the book under consideration gives us photographs and descriptions of some of the more important of the seventy-five species of wild birds which he has found nesting within a radius of ten miles of Whalley where he lives. He has made a special endeavour to illustrate the habits and life-histories of his subjects which has been crowned with success. It would be very difficult to obtain a better photograph than that of the barn owl which is used as a frontispiece, or of the tawny owlet which faces page 56. The series showing the story of the young cuckoo is also most attractive, and from this we are enabled by the courtesy of the publishers to reproduce the illustration which we give in Figure 55. The curlew and the woodcock might also be picked out for mention, and of the missel thrush Mr. Taylor has succeeded in getting some very pleasing pictures. The accounts of the birds and the details with regard to the way in which the photographs were obtained, as well as those of the apparatus used, should prove of interest and help to others who would fain follow in the footsteps of Mr. Taylor. He begins his preface with an extract from Gilbert White, and to the many disciples our great field naturalist we commend "The Birds of a County Palatine."

W. M. W.

Desert and Water Gardens of the Red Sea.—By CYRIL CROSSLAND, M.A. 158 pages. 91 figures. 12 diagrams. 9¾-in. × 6-in.

(The Cambridge University Press. Price 10/6 net.)

Biologists have, as is right, their own way of looking at things, and Mr. Cyril Crossland's account of the people of

FIGURE 55.

The Meadow Pipit feeding the Young Cuckoo.

(From "Birds of a County Palatine," by Alfred Taylor. By the courtesy of The "Wild Life" Publishing Company.)

XUM

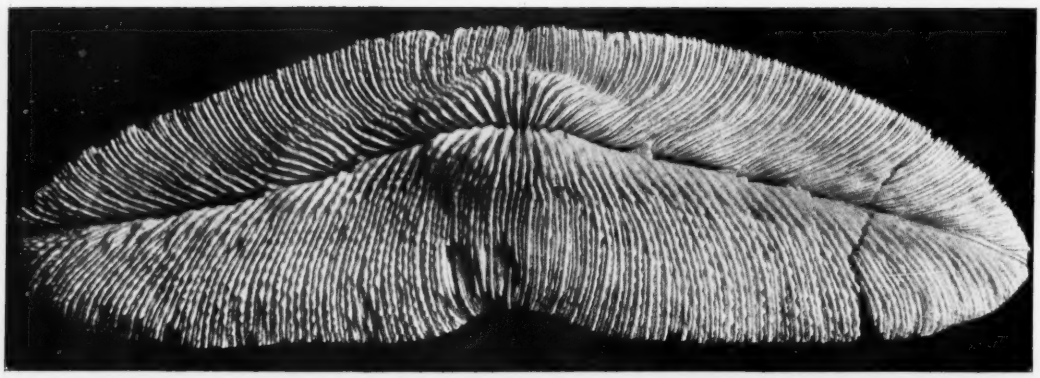


FIGURE 56. *Herpolitha*, an elongated fungid coral.

FIGURE 57. Old Coral bored by a mollusc (*Lithodomus*).

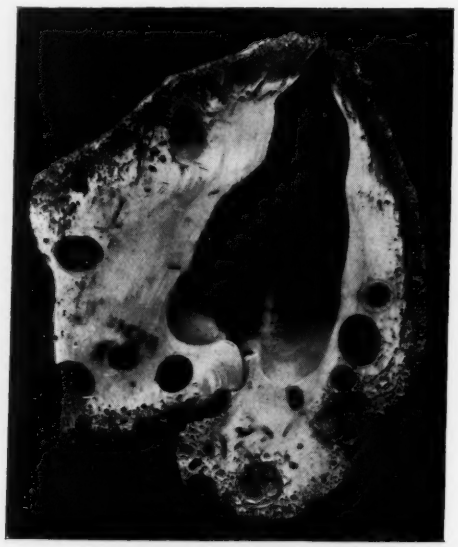


FIGURE 58. Section of a large Shell bored by molluscs and sponges.

FIGURE 59. The young form of the Mushroom Coral (*Fungia*).

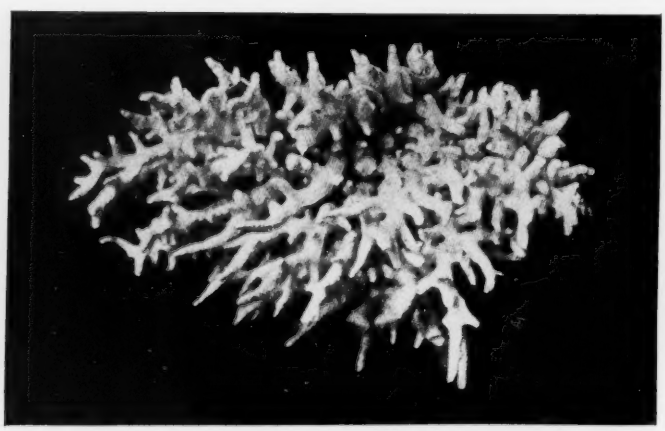


FIGURE 60. A stony Seaweed (*Lithothamnia*).

(From "Desert and Water Gardens of the Red Sea" by Cyril Crossland. By the courtesy of The Cambridge University Press.)

the Red Sea Coast is as fascinating as his description of the reefs and corals and sponges of the shore. We learn much of the daily life of the people, of their curious superstitions and their general behaviour. No one will kill a cat or drown young kittens, though they would bury superfluous puppies without any qualm. This Mr. Crossland thinks is a relic of the ancient Egyptians' reverence for the former animals. It is further suggested that the word "biss" which is the name for cat is the same as our word "puss" and arose independently in the two countries. Not the least interesting part in the book is that dealing with the sailors of the Red Sea, including those who are engaged in the occupation of pearling. Mr. Crossland's book is most attractive and should be read by everyone interested in his fellow-men. By kind permission we reproduce several of the illustrations (see Figures 56-60.)

W. M. W.

PERSPECTIVE.

Perspective made Easy by Means of Stereoscopic Diagrams.—By C. E. BENHAM.

(Colchester: Charles E. Benham. Price 6/-.)

These diagrams will prove of considerable help to those who have a difficulty in realising the different planes made use of in working out a perspective problem. The relative positions of the P.P., G.P., C.V., Eye, V.P's., M.P.'s, and other points are shown with the solidity associated with stereoscopic relief.

The accompanying pamphlet explains the theoretical part of the subject very clearly.

Teachers of Perspective should welcome these diagrams as a real help in imparting a knowledge of the subject.

It would be an advantage in a future edition to print the descriptions of the figures on the left side and under the left diagram. They could then be read when viewing the diagrams in the stereoscope.

E. J. B.

PETROLOGY.

Igneous Rocks. Vol. II.—By J. P. IDDINGS. 685 pages. 18 figures. 8 maps. 9-in. × 6½-in.

(Chapman & Hall. Price 25/6 net.)

The completion of Professor Iddings's great work on Igneous Rocks marks an epoch in petrological science. The first volume treated of the composition, occurrence, texture, and classification of igneous rocks—in a word, of their petrology. The present volume deals in natural sequence with their petrography—systematic description and geographical distribution. The book is on a scale that has never yet been attempted in petrological works. It marks the definite establishment of the quantitative spirit in petrology, and, as in other sciences, the substitution of qualitative by quantitative methods is bound to have an enormously stimulating effect on the science.

The book makes it clear that petrographers cannot afford to wait for a "natural" or genetic classification of igneous rocks. The factors on which a natural classification can be based have not yet been discovered. The author of this work and the other three petrographers (Cross, Pirsson, and Washington) with whom he was associated in the construction of the American Quantitative Classification assert that there are no natural factors as yet known which are suitable as a basis for classification. Hence they established the Quantitative Classification, based on chemical composition and treating igneous rocks as a series continuous in all directions, which is only capable of arbitrary subdivision into compartments of equal value, just as, for example, is the scale of temperature. It is hard for petrographers to controvert the philosophical basis of this classification; it is easier for them to criticise its architecture. On this ground it is to be feared that the verdict will be an adverse one. The majority of petrographers will probably come to the conclusion that the American Quantitative Classification is not suited to their working needs, since it is based on a factor (chemical composition) which cannot be immediately elicited from the rocks, and which cannot be utilised in everyday work because of the sheer impossibility of obtaining chemical analyses of all the rocks the petrographer wishes to classify. From a perusal of this work he will probably come to the conclusion that a quantitative classification based on actual mineral composition—that is, on modal lines rather than normative—is the one necessary to the future progress of petrology, especially when it is seen in this book that Professor Iddings has been obliged to invent a modal classification through which to utilise the Quantitative Classification.

The book is divided into two parts, the first dealing systematically with igneous rocks and their classification, the second with their geographical distribution to form petrographical provinces and regions. In the first part igneous rocks are divided into six groups on what, in the main, is a well-conceived and logical basis of mineral composition. These groups are as follows:—

I. Rocks characterised by Quartz.
II. ,, ,, ,, Quartz and Felspars.
III. ,, ,, ,, Felspars.
IV. ,, ,, ,, Felspars and Felspathoids.
V. ,, ,, ,, Felspathoids.
VI. ,, ,, ,, Mafic Minerals.

A welcome quantitative note is sounded throughout the whole system. Thus in Group I the quartz rocks are defined as those in which the ratio of quartz to felspars is greater than five to three. In Group II the ratio of quartz to felspar must be less than five to three, and greater than one to seven. Similar arithmetical boundaries are established in the other groups, and in most of the minor subdivisions. Thus Group III—felspar rocks—is subdivided as follows:—

A. Syenites — $\frac{\text{alkali felspars}}{\text{lime-soda felspars}} > \frac{5}{3}$
B. Monzonites ,, $< \frac{5}{3} > \frac{3}{5}$
C. Diorites and Gabbros ,, $< \frac{3}{5}$

With regard to texture each group is subdivided into (1) Phaneric and (2) Aphanitic; and the latter are described along with their phaneric equivalents. It is impossible to overpraise the thoroughness and care with which the descriptions are done. The book is a huge compendium of petrographical information, from which petrographers will draw for many years to come.

While, however, the classification is ostensibly modal, in practice the rocks are often assigned to their respective groups on the basis of the norm or mineral composition calculated from the chemical analysis by the methods of the American Quantitative Classification. Many anomalies result from this. For instance, a rock which contains little or no lime-soda felspar may be referred to monzonite on the ground that the anorthite molecule occurs in the norm. The constituents of the anorthite may be taken up in some of the mafic minerals, or occulted in solid solution within the alkali felspars, and thus fail to appear as lime-soda felspar (page 171). It may also be remarked that the ratio of alkali felspar to lime-soda felspar, used as a minor factor in classification (see above), might usefully be replaced by the ratio of alkali-felspar molecules to anorthite molecules, since the proportions of anorthite to albite are now usually obtained with great exactitude from the optical examination of the rocks. The use of lime-soda felspar is really the perpetuation of the "plagioclase," beloved of the qualitative petrographer, as a factor in classification.

Professor Iddings has evidently found it impracticable to use the ratio of "felsic" to "mafic" minerals, corresponding to Brögger's distinction of "leucocratic" and "melanocratic," as the first factor in his modal classification. Here it plays a subordinate classificatory rôle, whereas in the Quantitative Classification, based on the norm, the equivalent ratio of salic to femic minerals forms the basis of the principal divisions. This points to an exaggeration of the importance of this factor in the Quantitative Classification.

In the second part of the book the rocks are treated

as components of petrographical provinces and regions"; and, although this is in general well done, the field covered is so enormous that it gives the individual items an effect of scrappiness. The author has evidently ransacked the whole of petrographical literature, as is evidenced by the bibliography of nearly one thousand items given at the end of the book. Another extremely valuable feature is the collection of over two thousand chemical analyses of igneous rocks with their respective norms—a collection which has no equal in petrographic literature. As regards the accuracy of the analyses and norms only one of those tested by the reviewer was incorrect, that of a teschenite on page 528. The latter part of the book is marred by numerous misspellings of foreign names and by misprints.

In spite of some obvious defects, especially the failure (in the reviewer's opinion) to correlate the American Quantitative Classification satisfactorily with a quantitative modal classification, this book is the finest account of systematic petrography yet published, and should hold the field for a long period.

G. W. T.

PHYSICS.

Recent Physical Research.—By DAVID OWEN, B.A., B.Sc. 156 pages. 53 illustrations. 8¾-in. × 6-in.

(*The Electrician* Printing and Publishing Co. Price 3/-.)

This book is based on a series of articles which have been appearing in *The Electrician* during the last three years, and it represents a well-considered attempt to give a connected account of recent progress in certain branches of Physics. The rapidity with which new developments have appeared during the twentieth century is enough to appal the busy man for whom Science is a recreation or whose own line of work lies in a different direction. To follow intelligently the researches of J. J. Thomson alone may be possible for those who are able to attend his occasional lectures at the Royal Institution; but even these favoured persons will not be sorry to possess a concise account of his recent work on Positive Rays such as may be found in the first two chapters of this book. Other chapters consider Rutherford's work on the α-Particle, Curie's work on Magnetism, the Brownian Movements noticed by the botanist Brown in 1827 and more recently studied by Gouy, Einstein, and Perrin, the Pressure of Radiation, the Aurora, Free Electrons in Metals, and the very strange magnetic alloys composed of non-magnetic metals.

W. D. E.

TELEGRAPHY.

The Wonders of Wireless Telegraphy.—By J. A. FLEMING, F.R.S., Professor of Electrical Engineering in the University of London. 279 pages. 54 figures. 8-in. × 5-in.

(Society for Promoting Christian Knowledge. Price 3/6 net.)

The author of this book has already written for the same series "Waves and Ripples in Water, Air, and Aether" published in 1902, in the last chapter of which he gave a short account of radio-telegraphy, then in its infancy. The growing importance of the subject has led him to write a new book in preference to amplifying one chapter of an old one. Much has already been written on the subject, but there is room for a book which, although intended for the general public, does not shirk difficulties. Professor Fleming has faced the problem of explaining in simple non-mathematical language the facts prophesied by Clerk Maxwell, the follower of Faraday, and the forerunner of Hertz. He discusses at some length the history of the wave theory of light, and the nature of the aether. Then follows a chapter giving in historical sequence the development of our present views of electricity and the nature of electrons. After this the book becomes more technical in the sense of being confined to the explanation and history of the methods of producing and of detecting electro-magnetic waves. As is only natural, the Marconi system figures more largely than any other: but other systems are adequately described, and a few pages are given to wireless telephony. The book can be confidently recommended.

W. D. E.

THEOLOGY.

The Present Relations of Science and Religion.—By the REV. PROFESSOR T. G. BONNEY, Sc.D., F.R.S. 212 pages. 8½-in. × 5½-in.

(Robert Scott. Price 5/- net.)

This volume forms one of a series entitled "The Library of Historic Theology," edited by the Rev. Wm. C. Piercy, M.A. So much nonsense has been written in the immediate past concerning the relations between Science and Religion that there is every need for a sane book of this character, written by a man who is at once a scientific man of recognised standing and a believer in those eternal verities which transcend science. Science, if I may so put it, has only just recovered from the influence of materialistic metaphysics; but there is no other than a historical and accidental connection between them. In his first chapter Professor Bonney deals with modern physical science, and shows how its conclusions, so far from being antagonistic to religion, point to the existence of one mighty Power and Purpose sustaining all things. He then passes to the realms of biology and geology. He insists on the truth of Evolution, indicating at the same time that the influence of natural selection, though certainly of importance, has probably been overestimated. He is inclined also to believe in abiogenesis, as constantly taking place in Nature through the synthetic production of protoplasm, and in the possibility of its being effected in the chemist's laboratory: a belief which I certainly share. But he points out that there is nothing whatever in these views destructive of a spiritual concept of life or of the teachings of religion. He then proceeds to point out, in further chapters, that there is nothing in the teachings of science which denies the possibility of revelation or miracle. The laws of nature are not data of experience, but inductions therefrom. If an event is recorded contrary to what we regard as natural law, we have no right to deny the event because of our belief in the law—our induction may have been too narrow. The question is, rather: What evidence is there that the event did occur? I do not agree with Professor Bonney, however, when he argues that alleged miraculous happenings should be dismissed from consideration if they are not of high moral significance and indicative of some lofty purpose, on which grounds he bases a criticism of modern spiritualism, whose phenomena are mostly trivial in nature. This seems to me to be a departure from a consistent scientific empiricism; though, of course, the credibility of spiritists, to keep to his case in point, does often extend to ridiculous limits.

The conclusions of Professor Bonney's first two chapters may seem to some readers to be rather vague and negative. I do not see what else could be expected. Science and religion are distinct departments of human thought and activity. The one seeks only to coördinate phenomena, the other to transcend the phenomenal. As such they are complementary, not antagonistic. Science cannot prove the existence of God (though the conclusions of science can be and ought to be used by the philosopher for this purpose), nor can theology enlighten one concerning, say, the laws of astronomy. On the other hand, there is nothing in science which contradicts a genuine religious faith. This, as Professor Bonney points out, has not always been recognised in the past; scientific men have dogmatised about religion, and theologians have dogmatised about science, with disastrous results. However, a much improved condition now obtains. The essential truth of a religion is not destroyed by the errors of some of its exponents; and as a man of science Professor Bonney not only declares in favour of religion as against atheism or agnosticism, but definitely defends Christianity as the noblest, and, on historical and other grounds, most credible form of religion. I hope that his excellent book will be as widely read as it deserves.

H. S. REDGROVE.

SOLAR DISTURBANCES DURING DECEMBER, 1913

By FRANK C. DENNETT.

DECEMBER proved a very unsatisfactory month to the solar observer, eight days (2nd, 3rd, 6th, 7th, 10th, 11th, 15th, and 22nd) being missed entirely. On five days (1st, 16th to 18th, and 24th) faculae only were visible; on seven (9th, 12th to 14th, 21st, 30th, and 31st) dark spots were seen; but on the remaining eleven the disc was reported free from disturbance. The longitude of the central meridian at noon on December 1st was 277° 3′.

No. 17.—First seen on the 9th, a larger spot with two smaller ones following it apparently forming part of an imperfect ellipse. On the 12th there was a line of pores running obliquely from 25° to 27° S. latitude. Next day a curve of pores was at the western extremity, and one pore at the eastern. On the 14th a solitary pore was in the place of the leader, the outline of the area being brilliant with faculae, the latter remaining visible until the 16th. The leader had a maximum diameter of seven thousand miles, the group extending fifty-seven thousand miles.

No. 18.—A solitary pore upon the 12th, but on the 13th two small irregular spotlets, the area being marked by a dull marking on the 14th, and by a facula from the 16th until the 18th.

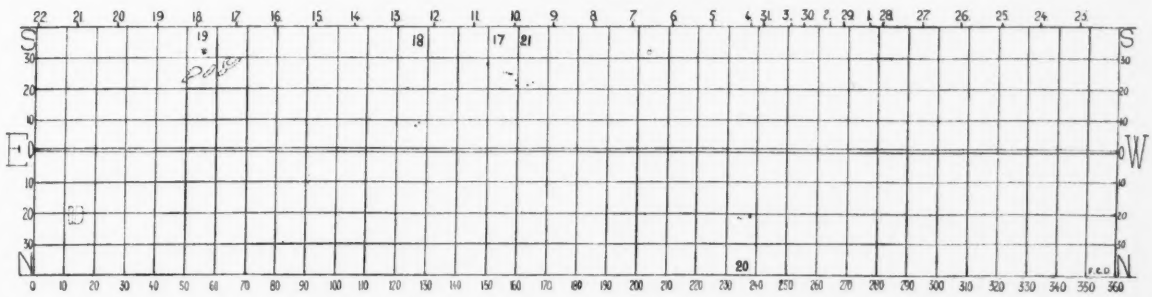
No. 19.—A tiny pore embedded in strong faculae. The position shown is approximate only. It was only seen on the 21st, the facula being near the limb on the 24th.

No. 20.—A group first seen on December 30th, somewhat protean in its character. The leader was single and the trailer double. On the 31st the leader was at first double, and later a chain of four pores, whilst the trailer was solitary, with a disturbed area between them. On January 1st the leader was at first like a spot with two umbrae, but the western one soon disappeared, a few pores being close by; the eastern spotlet now only a pore. On the 2nd the trailer seemed to be gone, but a new trail had broken out, with a more northern trend. On the 3rd the observation was somewhat unsatisfactory, and only the leader was seen. When the area was next visible, on the 6th, it was marked by faculae only. The leader attained a diameter of nine thousand miles.

No. 21.—A group of four spotlets first seen on the 31st surrounded by faculae. The components dwindled, and were last seen on January 2nd.

A faculic disturbance was seen December 1st near the north-western limb. Also on the 13th, at longitude 203°, S. latitude 32°. On the 13th and 14th a fine group of faculae was visible in longitude 48° to 68°, S. latitude 22° to 30°. A pale area of faculae around 13°, 20° N., visible on the 16th, probably a return of that seen on the 1st.

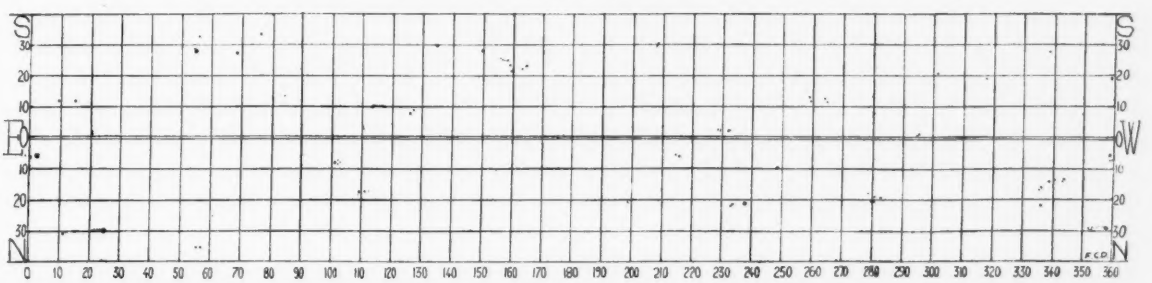
DAY OF DECEMBER, 1913.



The second diagram shows the distribution of spot disturbances through the year. The falling-off as compared with 1912 is very marked, as will be seen on reference to page 69 of our last volume. Another striking difference is that the mean latitude of the outbreaks is now so much farther removed from the Equator. In 1912 the majority of the spots were south of the Equator; in 1913 the numbers north and south are almost equal, the former being one to the good. The gathering of the outbreaks into groups, which has been so marked in previous years, is in this barely noticeable. There seems to be little doubt that the minimum has now been passed. Observations were made on three hundred and forty-three days, spots being visible on seventy-six, faculae only on one hundred and fifteen, whilst on the remaining one hundred and fifty-two the disc appeared free from disturbance.

Our monthly chart has been constructed from the combined observations of Messrs. J. McHarg, C. P. Frooms, and F. C. Dennett.

DISTRIBUTION OF SPOT-DISTURBANCES DURING 1913.



NOTICES.

THE SOCIÉTÉ GENEVOISE.—Mr. O. Paul Monckton, M.A., A.M.I.C.E., of 87, Victoria Street, S.W., has been appointed sole agent for Great Britain by the Société Genevoise which, besides making the line standards of length used in the National Physical Laboratory, manufactures dividing engines and machines for grinding gauges.

ALCHEMY AND THE KABALAH.—At a meeting of the Alchemical Society held on January 9th, Mr. Arthnr Waite lectured on " Kabalistic Alchemy," and made a very successful attempt to fix the approximate date of the Hebrew work known as *Aesh metzareph* the " Book of the Refining Fire " which survives only in the Latin Lexicon of Baron von Rosenroth.

ALLEN'S COMMERCIAL ORGANIC ANALYSIS.—The eighth volume of the new edition of Allen's Commercial Organic Analysis which Messrs. J. & A. Churchill are bringing out is now ready for publication. The subjects considered are enzymes, proteins of all kinds, milk and meat products, haemoglobin and its derivatives, and fibroids, each of which has been dealt with by an expert.

A BIRD SANCTUARY FOR BRIGHTON.—The Mayor of Brighton, Alderman J. L. Otter, when presiding at a lecture on the Brent Valley Bird Sanctuary, given in the Public Museum, made the statement that nothing would give him greater pleasure than that his year of office should be marked by the establishment of a bird sanctuary at Brighton. There will be some difficulty, no doubt, in getting the necessary land, but we hope that this may not be found insurmountable.

BAD GERMINATION OF WHEAT SEED.—A sample of wheat which was examined at Kew because its germinating power was not above fifty per cent. was found to contain, in the chaff, the fungus *Cladosporium gramimum*. So soon as the grains began to germinate the fungus started growth also and in the seedlings which died it was invariably found that the embryo was permeated by the mycelium of the fungus, while none was discovered in the seeds that germinated successfully and continued to grow vigorously.

THE LONDON NATURAL HISTORY SOCIETY.—The City of London Entomological and the North London Natural History Societies have now amalgamated to form the London Natural History Society under the presidency of Mr. L. B. Prout, F.E.S. A very successful meeting was held on January 6th, and the new society starts with two hundred and fifty members and associates. There are two branches (at Chingford and Woodford) and three secretaries, Messrs. T. R. Brooke, F.R.M.S., 12, Warren Road, Chingford ; J. Ross, 18, Queen's Grove Road, Chingford ; and H. B. Williams, LL.B., 82, Filey Avenue, Stoke Newington.

FLAX-GROWING IN ENGLAND.—Corn-growing has almost entirely ousted flax from England and so long ago as 1895 Mr. David Houston (*Biology Notes*, 1895) suggested that it might be cultivated again in Essex. Now we have before us a report (issued as a supplement to *The Journal of the Board of Agriculture* for January, 1914) dealing very fully with the possibility of reviving the flax industry in Great Britian. Botanists will find the historical review of interest, and the conclusions at which the compiler, Dr. J. Vargas Eyre, arrives are that, as the climate and soil of this country are suited to flax, the industry might, if managed according to improved methods, benefit British Agriculture; the plants being grown primarily as a fibre crop while at the same time the seed could be saved.

NEWTON & COMPANY'S LANTERN SLIDES.—Messrs. Newton & Company have sent for review the second part of their catalogue of lantern slides which extends to nearly six hundred pages, and we learn that its production cost more than one thousand pounds. Its object is to supply the enormously increased demand for lantern slides in schools, and in this connection Messrs. Newton, on page 901 of the catalogue, describe new school lanterns specially adapted for class work. There is an excellent index and six main subjects can be referred to instantly as the margins are cut down to the first page in each case so that the thumb may be inserted at the right place. Messrs. Newton are to be congratulated on the publication of the sets of lantern slides compiled by the Visual Instruction Committee of the Colonial Office and the Committee of London Teachers of Geography.

THE ROYAL ANTHROPOLOGICAL INSTITUTE.—At the annual meeting of the Royal Anthropological Institute, on January 20th, the President, Professor Keith gave an address on the " Reconstruction of Human Fossil Skulls." The lecturer maintained that the ordinary anthropological methods, which were employed for the examination and description of complete skulls were not applicable to fragmentary fossil skulls. During the last six years he had endeavoured to discover and perfect methods which might be employed in the reconstruction of skulls from fragments. Recently fragments of a human skull, representative of the pieces of a fossil human skull found at Piltdown, had been submitted to him for reconstruction. A cast of the original skull was kept by those who submitted the fragments to him. There was no apparent trace on the fragments of the middle line along the vault. The reconstructed skull, with a cast of the original, was submitted to the meeting.

CAN SELECTION IMPROVE THE QUALITY OF A PURE STRAIN OF PLANTS?—The claim of seed merchants that continued selection gradually improves varieties of plants, and that it is indispensable to keep up their quality, is examined by Messrs. C. and A. Hagedoorn in *The Journal of the Board of Agriculture* for January, 1914. The conclusion arrived at is that the seed of self-fertilised plants, which has been derived from one single plant of a pure strain by some generations of multiplication, is as good after ten or twenty generations as it was when it left the seed merchant.

The evidence brought forward in support of this opinion is very interesting. Between 1840 and 1850 Louis de Vilmorin started growing different varieties of wheat, and he kept an ear of every kind, with its name and date. The collection has been added to and the varieties are still grown by Vilmorin's son and grandson. Ears grown in the year 1911 have been photographed side by side with others from the original plants put by before the year 1850 and when a comparison is made no appreciable difference can be detected.

It must be added that if a seed merchant, however, sells a mixture in which some seeds—even a small minority—belong to a strain which does not come up to the standard, the seed cannot be multiplied indefinitely, for there is the risk that the plants of the inferior strain may take the upper hand. The authors think that there is really no excuse at the present day for merchants to sell anything but seed of absolute purity.

In habitually cross-fertilised plants such as rye and beet a continued selection by experts is most necessary, as under practical conditions no really pure strain can ever be produced by such plants. It is this fact that very probably has caused the unwarranted generalisation that the same holds good in the case of all agricultural plants.

XUM